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ELECTRIC LIGHTING OF SMALL TOWNS AND VILLAGES.

The object of lighting outlying places is a laudable one, and one which has to a very great extent been neglected, the large cities and towns absorbing all attention.

Why small towns and villages should not have electricity for power and light at their disposal when the same can, as will presently be shown, be accomplished if done in what seems to us to be the proper manner, we cannot comprehend.

It is well known that many a sound and commercial undertaking is ruined by heavy establishment charges. Reduce these to their proper proportion, and then there is a chance of the shareholders receiving some return for the money they have inverted.

Electricity works will never succeed, any more than do the gas works in small towns and villages at the present moment, as long as each is a distinct concern. By this is meant that the price can never be brought down sufficiently low to make the supply popular. Anyone who is interested in this subject, and who has gone to the trouble to inquire into the price charged by the gas companies in small towns, the quality of supply and the dividends paid to the shareholders, will find nothing but dissatisfaction. How often have we heard the remark "the price is high, the quality bad, and the dividends small."

What is wanted is a moderate capital expenditure, a simple and efficient plant, a good and constant supply, reasonable managerial expenses, strict economy in working, and a popular price per B.T.U.

How is this to be obtained? We venture to suggest a means.

We take a town which has an electricity supply owned by either a company or by the corporation. Round this town, at distances varying from, say, two to twenty miles, there are some half-dozen small market towns, where the supply of gas is bad, and the price high. One half of the population use other means of illumination, principally oil. The inhabitants would welcome the electric light, and many would gladly invest a considerable amount of money in laying down an electric light plant if it could be shown to be a sound commercial undertaking.

Now, we maintain that if plants installed by the owners of the installations in the large central towns, with a capacity sufficient to allow, say, the equivalent of 4,000 8-C.P. lamps, or even less, and controlled by them from the large town as a centre, the result would be a distinct success, for the following reasons.

A standard plant would be adopted, say, of 25 units each, and a set of spare parts would be kept in the central town to replace any part which may require repairs.

Two or more units would be installed in each town, also one or more banks of accumulators to supply the demand in the early morning and day time.

One man and a boy would be sufficient to take charge of each station. The engineer-in-charge of the central town station would have control of all these small plants, and receive from each a nominal salary, according to their individual success. Stores, &c., would be issued to each town as required, a sufficient reserve being stocked.

Weekly returns of stores issued and wages required, &c., would be supplied by the men in charge of each town once a week. Meters would be read by the man whose duty it is to do this work in the central town, and the accounts issued and money collected also by the offices at the central town. To each small town would be debited a proportion of these officers' salaries and other incidental expenses, such as stationery, &c., thus relieving the small towns of heavy management expenses, and at the same time relieving the central town of these amounts, and so making its own installation more profitable.

Take, for example, two dynamos and engines, 25 kw. each, switch gear, accumulators, boiler, buildings, mains, and incidental expenses, which would run into approximately £7,000.

This would provide a plant capable of maintaining, allowing the batteries to assist at top load, 2,000 8-C.P. lamps. As never more than half the lamps connected would be used at one time, 4,000 lamps could be wired.

The revenue for these 4,000 lamps, taken at the very low figure of 6s. per lamp per year, would be £1,200. The cost per B.T.U. to supply them should not exceed, as shown below, 2·75d. per B.T.U. sold, having regard to the fact that the plant when working will be running at full load, therefore most economically.

Wages—Man £78, Assistant £26	£104
Coal at ·75d. per B.T.U.	150
Oil, waste, &c.	13
Management, engineer's salary, &c.	100
Repairs and maintenance	50
Rents, &c.	100
Depreciation	150
Total	£667

On a revenue of £1,200, profit as shown above would be £533, or over 7½ per cent. on the capital outlay, £7,000.

It is apparent, of course, that this scheme is for a low tension continuous current supply, and that 7¾ per cent. dividend would be earned when the total capacity of the plant was taken up, which might be very soon accomplished at the popular price of 6d. per B.T.U., which is the figure given in the calculation.

Suppose only 2,000 lamps were connected for the first year, the result would be still encouraging, for the concern would be able to pay its way, as the following figures show.

Revenue from 2,000 lamps—8-C.P. lamps—at 6s. per lamp, £600. Out of pocket expenses :—

Wages	£104
Coal	75
Oil, &c.	7
Management expenses, salaries, &c.	75
Repairs and maintenance	50
Rents	100
Depreciation	150
Total	£561

There is no account taken of the profits made incidentally, such as connections to consumers' premises, meter rents, &c., as the desire is not to exaggerate matters, but to represent a few of the material facts of what we consider a practical scheme for enabling our neighbours in the smaller and less favoured towns to enjoy the many advantages and conveniences to be derived from the use of electricity as a motive power and for illuminating purposes, at the same time providing them with a profitable investment.

We are cognisant of the views of the advocates of high tension alternating current that the only proper way to supply electricity to the small towns and villages in the vicinity of large cities and towns is by means of mains communicating with the central station in the central towns, which would supply electricity to sub-stations in the outlying districts, where the pressure would be reduced for supply to consumers. But, assuming the current could be generated at the central station, and led to the sub-stations as cheaply as the method we advocate, there is the inevitable result, should any interruption in the supply occur, that some six or eight places would be plunged into sudden darkness; then again, the small high tension mains connecting one town and another might be liable to damage from a hundred and one causes, therefore it would be unwise to expose the lighting of a town to such risks, and at least two, if not three, experienced men would be required to attend to the sub-stations in each locality.

It is needless to say anything about the running of incandescent lamps in series or multiple series. Under some conditions, this method of connecting incandescent lamps is advantageous, but it is devoid of novelty. Lamps were so connected years ago, and no doubt at the present moment thousands of incandescent lamps are so connected and working satisfactorily.

Edmondson's Meter. THIS meter, which we describe in another column, belongs to a numerous class in which an ammeter or a wattmeter is combined with a registering apparatus. The novelty in this one is the use of a zero ammeter or wattmeter, with which is combined a pendulum motor and a registering train of wheels driven by a simple ratchet and ratchet wheel. Whether this meter will be a successful one or not, it is difficult to say; many meters on the same general principles have been devised, but none have been of much use. Compared with the class of meters employing a revolving mercury bath or a revolving armature in mercury, like the Faure, Ferranti, Perry, and other successful types of the Barlow's wheel order, the class to which this zero instrument belongs has been nowhere in the competition. This is possibly due to the complicated collection of moving parts required in them. Edmondson's meter, however, is well designed, and is based on sound reasoning, and may be the successful one of the class. Like most others of the kind it can be used for either alternating or continuous currents. It is wonderful how little we hear of meters in practice. Many thousands are in use, and much experience must have been accumulated regarding the different types, and we think that meters might with advantage form a theme for open discussion.

Patents. THE Cassels gold recovery patent case and other recent suits, reveal a somewhat alarming tendency on the part of the higher courts to set aside old patents brought forward as anticipations of new

patents, on the ground that the older invention was never commercially successful. Such a practice is exceedingly dangerous and quite contrary to patent law, as commercial success or failure of an invention can never have any legitimate influence as an argument in any patent case under our patent law, in a question of anticipation. Commercial success is dragged in to show that the new patent covers more than the old patent and, so far, is quite a proper argument, provided the additional invention is clearly proved and specified, but in recent cases where commercial failure of the old was held to prove it no anticipation, the additional invention assumed to be in the new patent was not even discussed in the decision.

Magnetism and the Weather.

ALTHOUGH much time has been devoted to the study of magnetic and meteorological observations with the hope of establishing a definite relation, the results, so far, have been chiefly of a negative order. Magnetic phenomena are extremely complex, and it is only making use of a trite expression to say that those of the weather are even more so. It is not to be wondered at, therefore, that the subject has not been advanced much beyond the empiric stage. At the basis of all such investigations must necessarily stand the facts ascertained or ascertainable concerning the three principal magnetic conditions or fluctuations. These fluctuations, so far as we know at present, are threefold, viz.—(*a*) the diurnal change, assumed to be due to some combined solar and terrestrial action; (*b*) the magnetic storms, understood to originate in the sun; (*c*) the gradual change in magnetism from one day to the next. The last named is quite singular, and has been studied more than any other in the hope of establishing some relation with the weather. Mr. H. A. Hasen, writing on this subject in *Science*, Vol. i. (New Series), No. 9, p. 234, states that after 13 years of study he is satisfied that the pressure of the air, or, perhaps, the fluctuations of "the dew point," are by far the best means to make use of in determining a possible connection between magnetism and the weather. He is also perfectly satisfied that the relation, if it exists, will be found to be only an indirect one. A connection has certainly been found, however, with auroras, and ascertained facts warrant the assumption that the diurnal range of air pressure is a thermo-electric phenomenon allied to the diurnal range in the swings of a magnetic needle; but we have, to date, very little positive knowledge on the subject. It is to be hoped that the continuous observations which have been carried on at Kew Observatory and elsewhere for so many years will soon be sufficient to enable some generalisations to be made which shall at least advance the study a stage, or shall make it clear that the energies of the observers were better expended in some other direction in which there is a more immediate prospect of result.

Current for Electrochemical Work.

FOR electrochemical laboratory work it is generally admitted that the most suitable source of current is a secondary battery, and when a dynamo is at hand it is also the most convenient. Even when the laboratory has no dynamo, there is often an electric lighting station in the town at which the accumulators can be charged. But when this fails recourse must be had to Bunsen cells. Daniell cells are much cheaper and cleaner to manage, and they give a steadier current, but their internal resistance is so great that only a small current is obtained even when several ordinary cells are used. A Daniell cell of the type used in the German imperial postal service gives only a maximum current of 0·2 ampère when short-circuited; but this small current, if used continuously, would suffice for charging accumulators such as are used for electro-chemical work in laboratories. For electro-chemical deposition an E.M.F. such as is given by two secondary cells in series is generally sufficient. For analyses according to Classen's system a current of not more than 0·5 ampère is required. Hence the chief requirements are evidently very modest. According to C. Heim, writing in the *Ber. d. Deutsch. Electrochem. Ges.*, 1894, 50, the secondary cells used in the German imperial postal service have a capacity of 15 ampère-hours and give a discharge current of 1—2 ampères, and can be bought at about 9*s.* each. Two such cells could be kept charged day and night, excepting when in use, by a dozen Daniell cells, which would give a charging current of 0·1—0·2 ampères. Daniell cells of the German postal type can be purchased for 12*s.* to 15*s.* per dozen. Assuming that about 1,000 ampère-hours are required in the course of the year, Heim calculates that the cost of materials for the primary cells would be 75*s.* for copper sulphate and 10*s.* for zinc, or 85*s.* per annum.

Magnetic Shielding.

THERE is still an amount of disagreement or divergence of opinion on the subject of magnetic shielding to warrant the conclusion that it has not yet been sufficiently investigated. The matters at issue are of sufficient importance to demand that more research should be undertaken and the doubtful questions elucidated. Some of our readers may be aware that O. Grotrian has given considerable attention to this subject, especially that branch of it which deals with hollow and solid cylinders and the distribution of magnetism within them. Grotrian considers the screening action of the hollow upon the solid cylinder or core; but M. Ascoli (*vide Wiedemann's Annalen*, liv. (1895) pp. 381—384), objects to the idea of "screening" in this sense, and argues that, according to the theory of magnetic circuits, the effect is more properly explained as being the result of the different specific resistances of the cylinder and core respectively. Whilst admitting that a sheet of iron acts as a screen towards a non-magnetic medium, or towards small magnetic bodies placed behind it in such a medium he considers that it is a misuse of terms to speak of a sheet as "screening" a medium having a permeability similar to its own. Doubtless we shall hear some more on this subject, meanwhile it does not appear to be settled whether magnetic screening is to be regarded as the action of a permeable magnetic jacket, or of an impermeable bounding medium, or of both.

The Electrostatic Capacity of Coils.

A SUGGESTIVE little paper was recently communicated by J. Cauro to the Paris Academy of Science on the subject of the electrostatic capacity of coils. As is well known, coils that are double-wound may be regarded as possessing a capacity which increases rapidly with the resistance, but as having a self-induction which is small enough to be negligible. In the ordinary method of estimating self-induction, the algebraic sum of the self-induction and the capacity is ascertained, and since capacity is equivalent to a negative self-induction, the result of such a measurement may be either positive or negative. If positive the algebraic sum may be made equal to zero by the introduction of a sufficient amount of paraffin so as to increase its capacity; if negative the self-induction may be increased by the introduction of a suitable soft iron core. The capacity may be considerable, and must be eliminated whenever the elimination of self-induction is considered necessary. Cauro relates that in his attempts to reduce the combined effect of self-induction and capacity in resistance coils, he has obtained excellent results by starting the winding of alternate layers of wire from the same end of the bobbin. For further details the original paper may be consulted, *q. v.*, *Comptes Rendus*, cxx. (1895), p. 308.

THERAPEUTIC ACTION OF HIGH FREQUENCY CURRENTS (M. D'ARSONVAL'S SELF-CONDUCTION).*

We have been engaged during the past year in trying upon a number of our patients the action of high frequency alternating currents generated in the human body by induction, with a view to arriving at the clinical demonstration of M. d'Arsonval's physiological discoveries in this direction.

Localised applications of these same currents to dermatology have already been made by Dr. Oudin, but their influence on the system generally, under the most diverse pathological conditions, had not been demonstrated at all. With this view we proceeded empirically applying almost uniformly the same treatment, which consisted in enclosing the patient in M. d'Arsonval's large solenoid for a period of 15 to 30 minutes each time and, as far as possible, every day. We took particular care to eliminate all other influences, either of special diet, or medicine, subjecting our patients to this treatment only.

From the 20th of January, 1894, to March, 1895, 75 patients (34 private patients and 41 hospital cases) have been treated in this manner, and during the same period 267 examinations of urine have been carefully made by M. Berlioz.

The total number of times that these patients were treated was 2,446.

We will now give the results, which have been faithfully recorded, whether positive or negative.

(*a*) *Negative Results.*—Certain forms of hysteria and of localised neuralgia, such, for instance, as neuralgia of the radial type proved absolutely refractory and derived no benefit from this treatment.

The examination of the urine of these patients, which was made a certain number of times during the course of these applications, showed besides that there had been no appreciable change in the composition of the urine, before and after the treatment.

(*b*) *Positive Results.*—The greater number of patients that derived a marked benefit from this treatment were those suffering from nutritive disorders, *arthritis*, *gout*, *rheumatism*, *glycosuria*, &c.

Nearly all of those showed a marked improvement; but those who derived the greatest benefit were arthritic subjects with articular or neuralgic symptoms. During the first trials, even before any apparent local influence or action on the urinary secretion was observed, the general health seemed to be beneficially influenced, and we noted from day to day the following general symptomatic improvements, making allowances for the slight differences of each particular case:

Restoration of strength;
Return of appetite;
Return of sleep;
Increased cheerfulness and energy for work;
The quieting of certain nervous symptoms;
More ease in walking, appearance improved, &c.

Subsequently, local troubles, either painful or involving loss of power, were gradually amended; thus a patient, who had been reduced to almost complete powerlessness by coxo-femoral arthritis, regained the use of her legs. Another who had been, through sharp pains, unable to close her hand, completely regained the use of it, &c.

Simultaneously with this symptomatic improvement the examination of the urine showed that the diuresis was becoming more satisfactory and that the organic matter was more easily eliminated. *Combustion was increased* as was shown by the diminution in the amount of uric acid, whilst the proportion of urea rose. The ratio between these two substances, which before treatment was very high, decreased gradually until it reached the mean proportion of $\frac{1}{40}$.

The elimination of the mineral elements was also influenced but in a less evident manner.

We will also mention, reserving to ourselves the right, however, to complete our first results on other patients of the same class, that, in three diabetic subjects, the quantity of sugar diminished considerably, even to the extent of disappearing altogether after a certain number of trials, without any other treatment. *In short*, the numerous facts that we have observed during the last year place us now in a position to support by a clinical confirmation M. d'Arsonval's physiological discoveries relating to the action of high frequency alternating currents generated in the tissues by induction.

These currents have a powerful influence on the nutritive faculties, and on this account they constitute a mode of treatment of the highest value in a large number of functional disorders caused by inaction or perversion of the nutritive processes.—Apostoli and Berlioz (*Revue Internationale de l'Electricité.*)

* Note presented to the Académie des Sciences, March 18th, 1895.

THE GUTTA-PERCHA SUPPLY.

We reproduce the following from the *Sarawak Gazette*, and although not too sanguine as to the commercial success of the project initiated by M. Hourant, we recognise the advantage of any attempt to put an end to the wholesale destruction of the *Isonandra*, a matter to which we have frequently referred. The article by M. Serullas referred to in the *Sarawak Gazette* was republished by us in December, 1890:—

"Any new industry successfully introduced into this country, must be looked upon as an important factor in our future prosperity, and we are therefore glad to be able to note that two enterprises which have, until recently, been unknown here, have been started; namely, the collection and export of the dried leaves of the gutta tree, and the manufacture of cutch from the bark of a variety of the mangrove which is found in almost unlimited quantity in the swamps on the coast.

"The former of these industries was commenced last year when a few small samples of leaves were forwarded to Paris by Mons. F. Hourant; there an excellent quality of pure gutta-percha was extracted from the leaves, which are said to yield from 7 to 10, or even more, per cent. of their weight of the manufactured article. After some difficulty in getting natives to work systematically at the collection of the leaves, which had hitherto been looked upon by them as possessing no value, Mons. Hourant is now exporting leaves in quantities which increase month by month, and has erected a factory in Kuching for the purpose of thoroughly drying them before shipment. The advantages of this method of obtaining such a valuable product as gutta-percha are evident. The native plan of cutting down a tree to obtain the sap was wasteful in the extreme. It has been estimated by carefully experimenting that an adult tree of 25 to 30 years of age yields of *pure dry* gutta only one catty; as much can be obtained from two pluckings of the leaves of a tree, without injuring it, and it will long continue to put out fresh foliage, and, what is more important still, will live to seed and reproduce its species; and the better kinds of gutta tree do not fruit until 30 years of age. The average gutta tree of 60 centimetres circumference at 5 to 6 feet from the ground was found to yield, by the native process, only $\frac{2}{3}$ths catty of pure dry gutta.* This is not so good as the 7 to 10 per cent. by weight obtained from the dried leaves; also, the gutta obtained from the leaves is chemically pure and dry, which is more than can be said of much of the Dyak gutta found in the bazaars. The millions of trees already destroyed by the native gutta hunters are still of service to Mons. Hourant, as their stumps have sprouted out into numerous small shoots, much in the same way as an osier does, and though these stems are too small to produce gutta, their leaves are as good as those of an adult tree.

"In these days when jungle produce is growing scarcer in the more accessible forests, when pepper, which was formerly a source of great profit to planters, is down in market value, all attempts at increasing the number of strings to the bow of the export trade of Sarawak, are to be welcomed, and it is to be hoped that, having overcome initial difficulties, Mons. Hourant will find his enterprise well repaid by substantial profits to himself and those associated with him in

* These figures are obtained from a paper on gutta-percha, by M. Serullas, who was indebted for them to a report by Dr. Burck, of Buitenzorg, who, in 1893, was employed by the Dutch Government to investigate the natural history, &c., of the different gutta producing trees of Malasia.

the work, and will long continue to swell the revenues of the Treasury by the export duties he pays on the leaves shipped.

"Of the cutch factory, which is in the neighbourhood of Santubong, we have heard but little, but trust that it also will prove successful under the care of its hard working promoter and manager, Mr. H. H. Everett."

ALTERNATE CURRENT MOTORS.

By W. G. RHODES, M.Sc.

(*Continued from page* 382.)

We had obtained the fundamental equation of the synchronous motor in the form

$$E^2 - e^2 - I^2 c^2 - 2 R p = 2 S \sqrt{c^2 e^2 - p^2}. \quad (3)$$

Squaring both sides of this equation we get

$$(e^2 + I^2 c^2)^2 - 2 (e^2 + I^2 c^2)(E^2 - 2 R p) + (E^2 - 2 R p)^2 = 4 S^2 (c^2 e^2 - p^2).$$

Now, multiplying throughout by $R^2 I^2$, and remembering that

$$I^2 = R^2 + S^2,$$

we can put equation (3) in the form

$$\{R^2 (e^2 + I^2 c^2) - I^2 (E^2 - 2 R p)\}^2 + \{R S (e^2 - I^2 c^2)\}^2 = I^2 S^2 E^2 (E^2 - 4 R p). \quad (4)$$

We will now discuss the fundamental equation, using the forms (3) or (4) to suit our convenience.

Particular Cases.—First, suppose that the machine is running at *no load*, so that we can approximately put $p = 0$; equation (3) then gives

$$E^2 - e^2 - I^2 c^2 - 2 S c e = 0 \quad (5)$$

Solving this equation as a quadratic in e we have

$$e = - S c \pm \sqrt{(S^2 c^2 - I^2 c^2 + E^2)}$$
$$= - S c \pm \sqrt{(E^2 - R^2 c^2)}$$

and since e is real, we must have

$$E^2 - R^2 c^2 \geq 0.$$

Therefore the maximum value of c is given by

$$c = \frac{E}{R},$$

the corresponding value of e being given by

$$e = - S c = - \frac{S}{R} . E$$

Again, solving (5) as a quadratic in c, we get

$$c = - \frac{S e}{I^2} \pm \frac{1}{I^2} \sqrt{(S^2 e^2 - I^2 e^2 + I^2 E^2)}$$

$$= - \frac{S e}{I^2} \pm \frac{1}{I^2} \sqrt{(I^2 E^2 - R^2 e^2)},$$

and deduce that the maximum value of e is given by

$$e = \frac{I E}{R},$$

when $$c = - \frac{S e}{I^2} = - \frac{S E}{R I}.$$

Also, since $$p = c e \cos \phi$$

when $p = 0$, we must have $\cos \phi = 0$, and, therefore, $\phi = \frac{\pi}{2}$, except when c or e is zero; thus the difference of phase between c and e is a right angle when the machine is running light.

We see, too, that equation (5) is satisfied by

$c = 0$ (minimum current),

and $e = E$, simultaneously;

and also by $e = 0$ (minimum counter E.M.F.)

and $c = \frac{E}{I}$ simultaneously.

By writing (5) in the form

$$\frac{(e + S c)^2}{E^2} + \frac{c^2}{\frac{E^2}{R^2}} = 1, \quad (6)$$

the curve drawn with values of e as ordinates and corresponding values of c as abscissæ; that is, the characteristic curve of the motor running light, is seen to be an ellipse.

Hence, when the motor is running at no load we have found that:

The maximum current is $\frac{E}{R}$, which is the same as would be produced by a steady E.M.F., E, acting in a circuit of resistance, R.

The maximum counter E.M.F. is $\frac{I E}{R}$.

When the counter E.M.F. equals the impressed E.M.F. the current is a minimum and zero.

The minimum value of the counter E.M.F. is zero when the current produced is the same as if there were no reacting field.

The difference of phase between the counter E.M.F. and the current is a right angle.

Now, let us find the *maximum power* which can be developed by the motor.

Referring to equation (4), we see that the right hand side can never be negative because the left hand side is the sum of two squares; therefore,

$$E^2 - 4 R p \geq 0,$$

therefore, the maximum value of the output is

$$p = \frac{E^2}{4 R}.$$

Substituting this value of p in (4) we get

$$\left\{R^2 (e^2 + I^2 c^2) - \frac{I^2 E^2}{2}\right\}^2 + \{R S (e^2 - I^2 c^2)\}^2 = 0.$$

Now, the sum of two squares can only be zero when each separately is zero, therefore

$$R^2 (e^2 + I^2 c^2) - \frac{I^2 E^2}{2} = 0,$$

and $$e^2 - I^2 c^2 = 0$$

simultaneously.

Solving these equations for c and e, we get

$$e = \frac{I E}{2 R}$$

$$c = \frac{E}{2 R}.$$

These are the effective values of the current in the armature, and of the counter E.M.F. corresponding to the maximum output.

Again, we have

$$e = I \cdot \frac{E}{2 R} = I c = e_0,$$

and $$\cos \phi = \frac{p}{c e} = \frac{R}{I} = - \cos \theta \text{ (see fig. 3)},$$

from which it follows that E is in phase with c, so that when working at maximum load fig. 3 becomes modified to fig. 4.

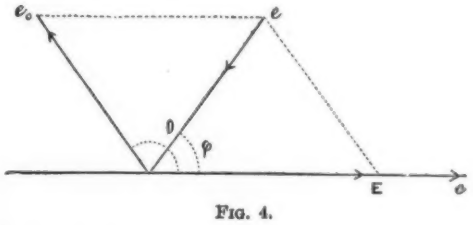


Fig. 4.

The input now is

$$c E = \frac{E^2}{2 R},$$

therefore the electrical efficiency is $\frac{1}{2}$, as it should be.

We find that at maximum output the output is $\frac{E^2}{4 R}$, or the same as the maximum power which a generator of constant E.M.F., E, can give to an external non-inductive resistance, R.

The current is one-half the maximum current at no load. The counter E.M.F. is one-half its maximum value at no load, and the current is in phase with the impressed E.M.F.

We now proceed to find the *minimum current* corresponding to *any given power*. Let ψ be the difference of phase between E and c, then the power given to the motor, or the "input," is

$$p + c^2 \, \mathrm{R},$$

and also is

$$\mathrm{E} \, c \cos \psi ;$$

therefore

$$p + c^2 \, \mathrm{R} = \mathrm{E} \, c \cos \psi. \qquad (7)$$

It is our object to find what value of ψ corresponds to the minimum value of c when p, R and E are constant. Differentiating the above equation, with respect to ψ, we get

$$(2 \, c \, \mathrm{R} - \mathrm{E} \cos \psi) \frac{d \, c}{d \, \psi} + \mathrm{E} \, c \sin \psi = 0,$$

and the condition that c may be a minimum is

$$\frac{d \, c}{d \, \psi} = 0,$$

which gives

$$\sin \psi = 0,$$

that is

$$\psi = 0,$$

or the current is a minimum when it is in phase with the impressed E.M.F. This is otherwise obvious, since for a given power the current must be a minimum when it has no wattless component; that is, when it is in phase with the impressed E.M.F.

Putting $\psi = 0$, equation (7) may be written in either of the forms

$$p + c^2 \, \mathrm{R} = \mathrm{E} \, c \qquad (8)$$

$$\left(c - \frac{\mathrm{E}}{2 \, \mathrm{R}} \right)^2 + \frac{1}{\mathrm{R}} \left(p - \frac{\mathrm{E}^2}{4 \, \mathrm{R}} \right) = 0 \qquad (9)$$

The equation in either of these forms gives the minimum value of the current for any given output, or, if we vary the output, gives us the relation which exists between p and c when c is a minimum, and we could show the relation graphically by drawing a curve with values of p as ordinates, and corresponding minimum values of c as abscissæ. Equation (8) shows that such a curve would pass through the points

$$\left. \begin{matrix} p = 0 \\ c = 0 \end{matrix} \right\} \text{ zero current and zero power,}$$

and

$$\left. \begin{matrix} p = 0 \\ c = \frac{\mathrm{E}}{\mathrm{R}} \end{matrix} \right\} \text{ maximum current and zero power,}$$

and equation (9) shows that it would pass through the point

$$\left. \begin{matrix} p = \frac{\mathrm{E}^2}{4 \, \mathrm{R}} \\ c = \frac{\mathrm{E}}{2 \, \mathrm{R}} \end{matrix} \right\} \text{maximum power.}$$

We will now apply our calculations to a particular case.

Suppose a 100 kilowatt motor is driven by a 3,000 volt generator, and that the resistance of motor and line is 15 ohms, and the reactance is 30. Then the impedance is 33·54.

At maximum output we then find:

p = 150 kw.
e = 3,354 volts.
c = 100 amperes.

At no load, maximum current = 200 amperes.
maximum value of e = 6,708 volts.

It will be seen that the counter E.M.F. of the motor may be greater than the terminal impressed E.M.F., and in this respect differs from a direct current motor; for in transmission of power by direct current methods the generator must always have a larger E.M.F. than a motor which it drives, but with alternating currents a machine of smaller voltage may drive, as a motor, one of higher voltage. The reason of this is easily seen, since

$$c \, e \cos \phi + c^2 \, \mathrm{R} = c \, \mathrm{E} \cos \psi$$

and by making ϕ large and ψ small, this equation may still be true even if e is much greater than E.

In order that the efficiency of transmission may be as high as possible, the current must be a minimum since then the c^2 R losses will be a minimum. We have seen that the current corresponding to a given power is a minimum when the difference of phase between it and the impressed E.M.F. is zero, so that the maximum efficiency will be attained when the power given out by the generator is accurately measured by the product of the volts at its terminals and the amperes in the circuit.

In order to determine practically the minimum current corresponding to a given power, it is advisable to obtain the characteristic curve of the motor corresponding to the particular output. Fig. 5 gives the characteristic of a 100 kw. motor, the impressed E.M.F. being 1,000 volts. The curve

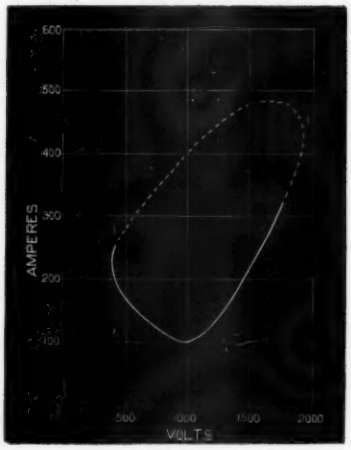


Fig. 5.

shows that corresponding to a given value of e there will be two values of c.

We also see from the curve that the theoretically best point to work at is that for which c is about 100, and e = 1,000. If by diminishing the exciting current we continuously reduce e, we shall arrive at a point where the two corresponding values of c coincide, and on still further reducing e there is no corresponding value of c, that is, the motor will fall out of synchronism and will stop.

(To be continued.)

RECENT EXPERIMENTS ON THE ELECTRIC DISCHARGE BY LORD ARMSTRONG.

At the last conversazione of the Royal Society, Lord Armstrong exhibited on the lantern screen a remarkable series of photographs and dust figures produced by the action of very powerful electric discharges. Most of the effects were obtained by the use of a large multiple Wimshurst machine, having 16 plates of 34 inches diameter, made by Newton and Co., and capable of giving a spark of about 17½ inches. The machine was fitted with two 10-gallon Leyden jars, as condensers, and was found perfectly adapted for the purpose of the experiments. The photographs were mostly obtained by the well-known method of causing the discharge to pass over the surface of a photographic plate with which the electrodes had been placed in contact. The dust figures were produced by discharging on glass or metal plates over which had been sifted various more or less non-conducting powders, such as calcined magnesia mixed with carbon in the form of lamp-black, tripoli powder, and hard carbon reduced to a fine powder. We are able this week, by the courtesy of Lord Armstrong, to reproduce what appears to us some of the most suggestive figures. Many of the results obtained appear to be quite inexplicable; they are, therefore, all the more interesting to the electrical theorist, and no doubt when the true explanation is arrived at, we shall have made a great advance in our knowledge of molecular physics, and of the true nature of electricity.

An exceedingly interesting experiment performed by Lord Armstrong in 1843, and repeated in an improved form before the Literary and Philosophical Society of Newcastle. in 1893, appears to throw a good deal of light on some of the results shown in these figures. In the experiment as originally performed, two wine glasses were filled to the brim with chemically pure water, and the two glasses were connected by a cotton thread coiled up in one glass, and having its shorter end dipped into the other glass. On causing a strong current to pass across the moist thread from one glass to the other in the right direction, the coiled thread was rapidly drawn out of the vessel containing it, and deposited wholly in the other, a rope of water being left suspended for a few seconds between the lips. In the improved form of the experiment shown in 1893, a glass bulb was used having a long neck on one side and a short nozzle on the other, the nozzle having an aperture of $\frac{1}{10}$th of an inch in diameter. Through this aperture a string composed of spongy cotton thread was passed. The string was barely sufficiently thick to fill the aperture, and was secured by a knot or otherwise to a conducting wire which entered the bulb through a cork at the top of the neck. The bulb was plunged into a glass cistern filled with distilled water, which was also allowed to fill the bulb. When a positive current was sent into the bulb, the water in the cistern being connected with the negative pole, the cotton was seen to climb up into the bulb, while a current of water could be seen flowing downwards out of the bulb all round the cotton. On reversing the cur-

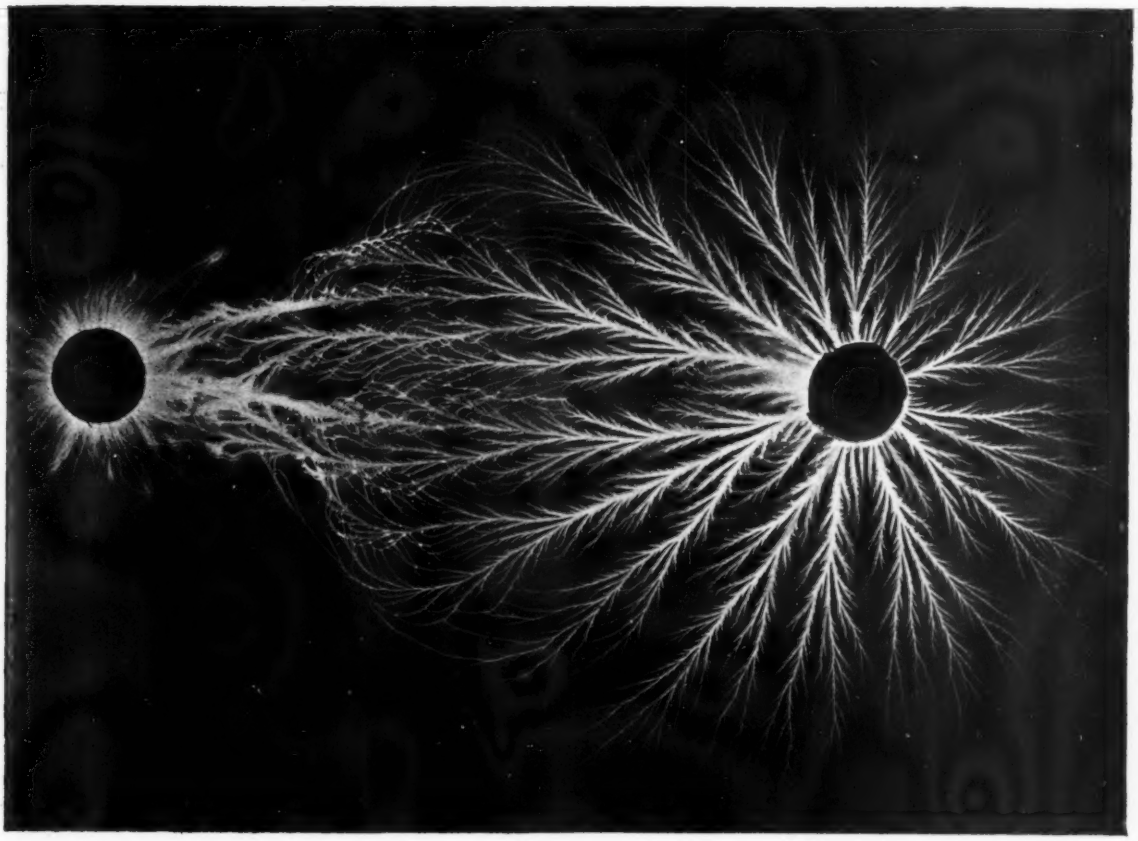


Fig. 1.

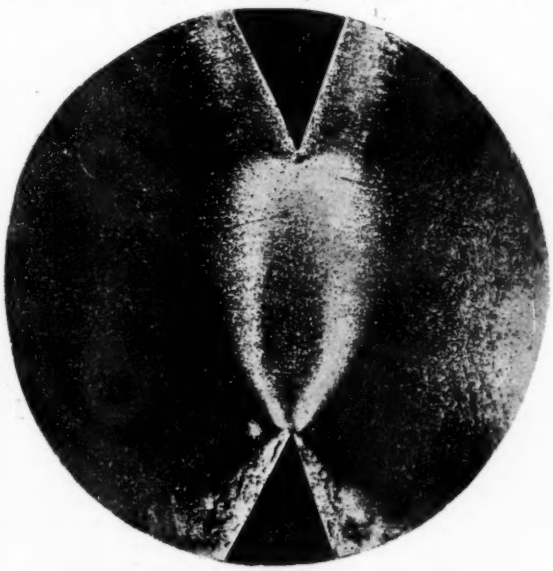


Fig. 2.

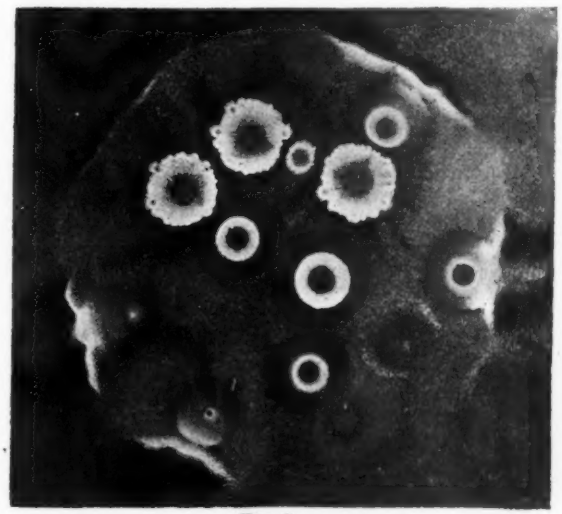


Fig. 3.

rent the movement of the cotton was reversed; the cotton always moved opposite to the conventional direction of the electric current, *i.e.*, towards the positive pole.

In many of the figures this tendency of the discharge from the positive pole to flow outside and encircle the discharge from the negative pole is shown in a remarkable manner. In the photograph, fig. 1, the branching discharge which radiates in all directions from the positive pole is seen to encircle the compact bundle of sparks proceeding from the negative pole. The way in which the terminations of the positive sparks bend towards the central negative current of sparks is especially noteworthy. The two currents

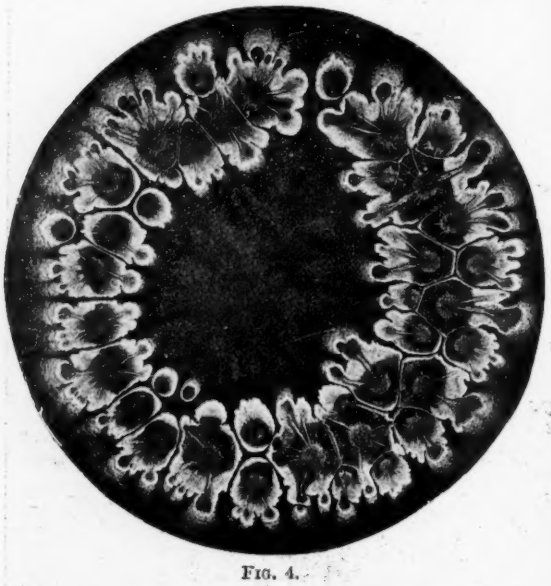


Fig. 4.

acting together appear to be striving to form a kind of vortex ring. Lehmann has actually produced vortex rings by discharging from a pointed electrode in certain liquids. The dust figure (fig. 2) shows very distinctly what appears to be a vortex ring or tube circulation between pointed electrodes. Fig. 3, which is produced, like the Kundt figures, by discharging upon a negative terminal coated with a film

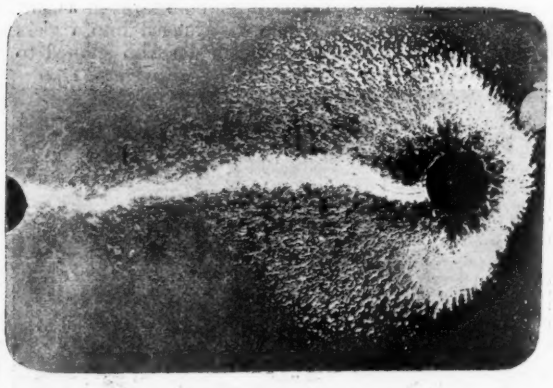


Fig. 5.

of dust, appears to show a section of the vortex tube circulation. As Lord Armstrong describes it, the effect resembles that which would be produced by sucking up a tube, and blowing down the annular space surrounding it. The general shrinkage of the dust film and the breach of continuity at the margins is noteworthy; also the tendency to form separate craters representing the sections of the hypothetical vortex tubes. This tendency of the small craters to preserve their individuality is still more remarkably shown in fig. 4, which represents a dust figure produced by a shower of negative lines discharged from a ring. The dust craters are crushed out of their natural circular form by overcrowding, but show no tendency to coalesce. Fig. 5, which is a dust figure formed by a spark, shows again the central circulation of the dust from the negative to the positive pole, and the outer return current. Fig. 6 is a dust figure produced by the passage of a very powerful electric

Fig. 6.

spark. The loose dust is swept off or thrown into confusion by the violence of the spark; but the finer particles adhere to the glass, and retain the markings impressed upon them.

(To be continued.)

THE ZERO-TORQUE ELECTRICITY METER.*

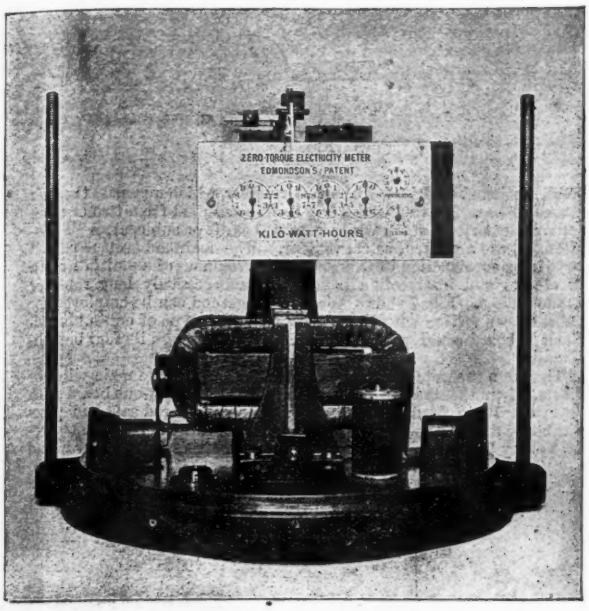
By JOSEPH EDMONDSON.

The zero-torque electricity meter, as its name implies, consists of a zero-reading dynamometer, combined with mechanism for measuring and integrating, at short intervals, the torque exerted on the moving coil by the current going into consumption.

The Siemens dynamometer is familiar to electricians as an instrument of the utmost simplicity and accuracy, giving, when coupled as a wattmeter, absolutely proportional readings throughout any range. Its obvious advantages in these respects point to it—in a form somewhat modified, but retaining all its essential features—as a

* Paper presented to the Institution of Electrical Engineers.

pre-eminently suitable basis for a supply meter, and numerous attempts have been made to adapt it to this purpose. Heretofore, however, the action of all such instruments has depended on complicated arrangements for making and breaking contact. In the zero-torque meter these are entirely avoided. The moving coil of the dynamometer is in a closed circuit which is never broken. It carries a small steel stop which controls the registering without in the slightest degree interfering with the *free* and *frictionless* action of the instrument.



The motion of the moving coil being limited to an arc of less than 1°, permits the use of a durable steel wire suspension instead of the delicate suspension of the ordinary dynamometer. A torque of about 90° is given to the usual spiral spring every two minutes by a reciprocating quadrant, or "mangle-wheel," driven by a vibrating motor consisting of a magnet and its armature. This motor is controlled by a small gravity-driven pendulum, starting automatically and having a sparkless contact (Oulton & Edmondson's patent).

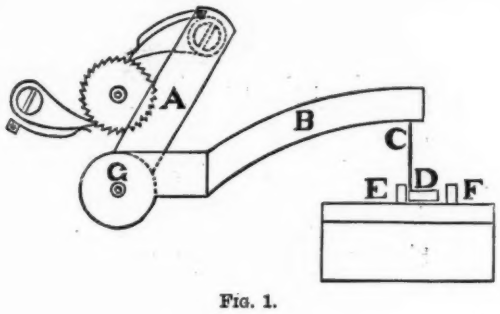


Fig. 1.

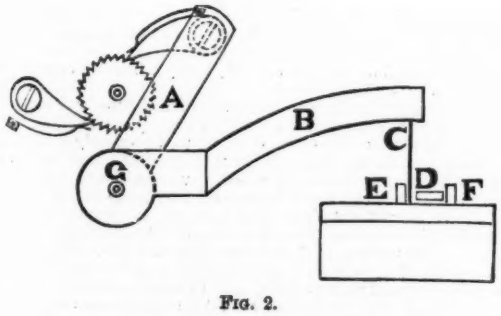


Fig. 2.

The action of the instrument is illustrated by figs. 1 and 2, in which A is an arm pivoted at G, carrying a click working into a ratchet-wheel, and driving the registering train. It receives a reciprocating motion from the vibrating motor. Fixed on its arbor is the arm, B, carrying the steel pin, C. The flat steel stop, D, on an arm projecting from the moving coil of the dynamometer, is free to move between the stops, E and F. When the current is *nil* the stop, D, remains against the stop, E, as in fig. 1. In this position the pin, C, comes down upon it at each vibration, and the arm, A, is thus prevented from vibrating far enough to take a tooth of the ratchet wheel. The registering is therefore *nil*. But when the force of the current moves the stop, D, to the right, and it assumes the position shown in fig. 2, the pin, C, can descend into the space between the stops D and E, the arm, A, can vibrate to its full extent, and the registering proceeds. This continues until the reciprocating quadrant, or "mangle-wheel," in its motion to the left, acting through the spiral spring, exerts on the moving coil of the dynamometer a torque equal to that exerted by the current, brings the stop, D, back to the position shown in fig. 1, and stops the registering. This action is repeated with each reciprocation of the "mangle-wheel."

As the period during which the registering proceeds is *exactly proportional* to the torque exerted by the current on the moving coil of the dynamometer, the diagram of registration is a straight line.

A 25-ampèremeter will register from $\frac{1}{10}$th ampère upwards.

The total current required for the shunt circuit and the vibrating motor never exceeds, and is generally less than $\frac{3}{100}$ths of an ampère.

The moving coil of the dynamometer, being in the centre of a cylindrical iron case, is shielded from external magnetic influence.

The meter is calibrated to read direct in kilowatt hours with a constant of 1.

INTERIOR CONDUIT WIRING.

The question of interior wiring is of pressing importance at the moment, and anything that will help us to get away from the danger and trouble that may arise from present methods is to be welcomed.

A system which has been lately put upon the English market is that pioneered and championed by the Interior Conduit and Insulation Company of New York, U.S.A. This company has consistently advocated the principle of wiring to lamps, motors, or other translating devices in the consuming or customer's end, through a system of insulating tubes, or continuous raceways, which can be laid throughout a house after the manner of gas or water pipes. In these tubes, the wires for any system of electric supply, one, two, or three-wire, continuous or alternating, can be drawn whenever required.

Absolute immunity from fire risk, durability of insulation, reliability of service and accessibility of concealed wiring, are the main features claimed.

The details of the system have been supplied to us by Mr. Fred Bathurst, who is exploiting the article over here. The basis of the system is an insulating tube. This is now manufactured in three grades or qualities, the plain tube, the brass-covered tube, and the iron-armoured tube. The plain tube is waterproof and electrically fireproof, but in certain severe or exposed positions found in practical work, it has been found advantageous to provide extra mechanical covering in the shape of brass or iron, to enable it to fill all requirements. The main field of application for these mechanically protected tubes is in those open air channels or shaftways where flames, originating at the bottom, might be enabled to travel upwards through the shaft. The insulating tube is constructed by a carefully worked out and patented process, employing a special grade of compound impregnated paper, which, whilst being practically fireproof, is sufficiently smooth and tough and strong enough to lend itself to manufacture. In order that the tubular form will be retained under all conditions, the walls of the tube are built up spirally, and the completed tube, after a further cementing treatment and impregnation in an outside waterproof compound, becomes almost homogeneous in texture. It is claimed that the plain tube will withstand the deteriorating action of ordinary plaster and some cements, so as to admit of its embedment in the same, and installed in this way, will form a fireproof, waterproof and insulating channel, in which ordinarily insulated wires can be enclosed with satisfaction and economy. It should be noted that certain *caustic cements* used in some parts of building construction appear destructive to nearly any material embedded in them. These conditions have been satisfactorily met by the employment of *brass-covered* tubes.

A system of conduits of this nature supplies also a supplementary insulation to that of the wires, with the result that very much higher insulation tests can be obtained and permanently maintained. The tubes are supplied in standard 10 feet lengths, and for the convenience of erection, have one end ready fitted with a coupling socket. Standard sizes from ½-inch to 2½ inches diameter are manufactured. The ordinary form of coupling socket adopted for the plain tube is shown in fig. 1, and consists of a thin metal sleeve. The end of the

Fig. 1.

tube to be joined on is first cut square with an ordinary handsaw, and then reamed inside and out with a suitable reaming tool. The end is then slightly warmed over a small flame, so as to soften the outside waterproofing compound, which has the effect of lessening its outside diameter, so that the end slips firmly into the sleeve until it finds its bearing against the end of the other tube therein. The softened compound makes a sealed joint, whilst the application of a pair of clamping pliers indents two rings in the soft metal sleeve, and serves to make a firm and mechanical joint. The jointing operation is practically the same for the brass-covered tubes, except that the brass has

first to be cut back by means of the trimming tool. The couplings for joining brass-covered tubes (fig. 2) are also provided with an internal insulating sleeve, which covers the ends of the tubes at the point of abutment. Joints of this nature can be completed in less than half a minute, and when properly made, are said to be moisture-proof and mechanically tight, and do not increase the diameter of the tube.

Fig. 2.

In order to meet the requirements of practice, a series of standard bends and elbows (fig. 3) and intersection or fishing boxes (fig. 4) are provided. These preserve the continuity of the tube system from fuse board to fixture, or from fixture to switch outlet. By providing elbows ready made which are applicable to ordinary conditions, much labour of erection is saved, and the work of would-be careless workmen

Fig. 3.

is neutralised. It is found possible to draw branch wires round three or four elbows with ease, but when more than this number occur on a "run," a fishing box is usually inserted amongst them so as to form a convenient point from which wires can be drawn in from either direction. The boxes are also very convenient for turning abrupt angles or corners.

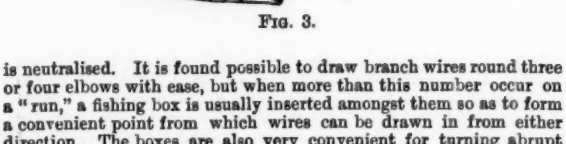


Fig. 4.

Fig. 5 shows in diagram the alternative application of a three-point box, or the use of two elbows; this latter construction necessitating an extra length of tube and "running back" of wires. The box method would be favoured where the tubes are between floors, or accessible on the surface, whilst the elbow method is followed where the work is completely plastered in, and the wires have to be accessible between the outlet points.

Fig. 5.

The "fishing wire" consists of a narrow band of steel fitted with brass ends. By means of this device, a string or cord can be drawn through the tubes after their erection, and the wires for the different circuits drawn in and connected up when desired.

The drawing-in process can often be facilitated by blowing powdered soapstone into the conduits before inserting the wires. This material reduces the friction of the wire, although as the interior of the tube is free from imperfection and perfectly smooth, very little difficulty is ever experienced. (In practice, it is found best to work in runs which do not exceed 50 or 60 feet in length.)

With these tubes there is no fear whatever of the insulation on the wires being torn and abraded, as so often happens in the case of ordinary metal tubes.

The tubes are secured in position by various devices suitable to the nature of the support, saddles, wire or strip fasteners, or pipe nails being chosen according to the conditions.

Fig. 6 illustrates a means by which a quick, well-finished and workmanlike job can be effected in respect to a switch wire outlet. This practice is applicable either to surface or buried work. The terminal wood block which receives the tube is made of hard wood, and soaked in a moisture-repelling compound. In the case of surface work, and where the switch base would not cover the back block completely, the ordinary polished switch block can be placed between the base and the back block. In order to use a conduit system to the best advantage, the work should be laid out in sections, and in the case of large buildings it may be advisable to work with a number of sections.

Fig. 6.

Each section should be fed by a vertical riser, which may pass through several floors. By this means any floor is supplied from two or more independent risers, upon which cut-out boards or sub-centres of distribution are arranged, as convenient. The main advantage gained by wiring construction of this sort is the avoidance of a multiplication of elbows and intersection boxes with unnecessarily long runs for branch wires. Fig. 7 shows how such a method can be employed for tubes in connection with the standard English type of cut-out board. Such a board could perhaps feed 20 lights through its four branch-circuits.

Though a separate tube is advocated for each of the main wires or risers, when the branch wires radiate from the cut-out board with less than 10 to 12 ampères on them, it is considered safe and practicable to draw them together into one tube, care being taken to protect every branch circuit by the double-pole fuses on the board, and

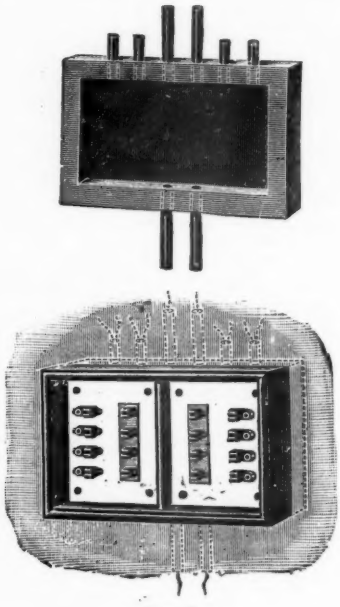


Fig. 7.

further safeguarding the sub-branches by means of the fuses found in switches and ceiling roses. It has been found possible with "interior conduit" tubes to completely "burn out" a wire within them by means of an excessive current, and yet have no trouble outside the tube.

Electrolytic troubles from the presence of moisture (and moisture seems to appear at some points in spite of every precaution) with this system of insulating tubes are claimed to be *entirely eliminated*. When wires encased in these insulating tubes fail at any time, by reason of defective insulation or careless over-loading of the circuit, such defective wires can be withdrawn from outlet to outlet and new wires substituted without destroying walls or ceilings, and with the *least* inconvenience and trouble. It is also possible to design a wiring system in which there is a minimum number of joints. It is thought that this point alone will confirm contractors in its favour, and testify to the possibility held out of being able to reduce the labour expenditure necessary on installation work by some 30 to 50 per cent. without in any way decreasing the effectiveness or reliability of the work.

Coming, now, to the general advantages offered by this method of wiring, its advocates maintain that the use of electricity for illumination and power is already so well established as regards the service to be expected, that no excuse is needed for the presentment of a complete, economical, and satisfactory system. The fact that a complete system of tubes *can* be laid throughout a building during its construction, after the manner of gas or water pipes, so as to provide

insulating ducts or raceways for the reception of the conducting wires, and make them perfectly accessible at all times, either for inspection, renewal, or repair, is of itself sufficient to warrant the adoption, even regardless of the other factors of merit this system possesses.

As to what has already been accomplished in Europe, it might be mentioned that four years ago the system was inaugurated in Germany, and the lapse of this time has sufficed to make it recognised as the *standard system* of wiring. It is claimed that no public building or construction of any importance in Germany in which electric wires are to be installed, will now be found in erection or contemplation without its equipment on "interior conduit" tubes. Buildings of all degrees of use and convenience, from the palace of the Empress Frederick at Cronberg to factories equipped by such firms as Siemens & Halske, Schuckert, Pieper, Breguet, Pitot, Maschinenfabrik Oerlikon, Helios Company, Lahmeyer, Naglo Bros., &c., are held to be sufficient evidence that this system possesses advantages that can appeal to the English market. For the past two or three years, certain enterprising English firms have been using this material regularly in those situations where their judgment led them to prefer it to any other material obtainable. Now, however, arrangements are being completed by which the General Electric Company will have an exclusive sales agency, and will push the system in its entirety on favourable terms.

LONDON CHAMBER OF COMMERCE: ELECTRICAL TRADES SECTION.

At the annual meeting of the London Chamber of Commerce held on Tuesday last at the Chamber, Eastcheap, Sir Albert Rollit, M.P., presiding, the report referred to the Electrical Trades Section as follows:—"Twelve meetings of this section and its committees were held during the year. The Chamber had under its consideration the advisability of the industry as a whole lending its support to the Antwerp Exhibition, and a circular was issued with the object of ascertaining what support was likely to be forthcoming, to which, however, there was no practical response. Early in the year the Traction Committee had an interview with the officials of the Board of Trade with reference to the draft of the Protective Powers Regulations, and a set of rules was ultimately issued which were believed to be satisfactory to the various interests concerned. Subsequently the Traction Committee made representations to the Postmaster-General with reference to what is known as "the Postmaster-General's clause," and satisfactory assurances as to the due protection of the traction interests were obtained. Special attention was given by the section to the rating of electrical works, a small committee being appointed to deal with the matter, and a large amount of evidence as to the anomalies of the present system was obtained. The section took joint action with the Engineering and Allied Trades Section in regard to the question of light railways as raised by the Board of Trade. Steps were also taken by the section to bring their views before the Board of Trade inquiry as to the placing of transformer chambers in the public streets, and a resolution was passed expressing the opinion that such chambers would not be dangerous to the public, and could be constructed so as to form no serious obstacles to the future use of the streets for other necessary purposes. The decision ultimately arrived at by the Board of Trade was considered favourable to electrical companies."

THE TELEPHONE SERVICE: PARLIAMENTARY INQUIRY.

Mr. Arnold Morley (Postmaster-General) presided over the resumed sitting of the Telephone Committee on Tuesday last week.

Major-General Webber, C.B., examined by Sir Charles Cameron, said that he was connected with the Royal Engineers, and had had divisional charge of the telegraphic service. He had also charge of the telegraphic service in the Egyptian war, and at present he was connected with electrical undertakings, both telegraphic and telephonic. He became acquainted with the early telephones in 1878 and 1879, and made experiments with them. In 1884 he read a paper before the Society of Arts, the purport of which was to show how cheaply the telephone could be introduced into England. In 1885 he was appointed technical adviser to the New Telephone Company. That was a company that came out with a view to competing with the National Telephone Company. His paper in 1884 was opposed to the monopoly in the telephone service, and he pointed out that, in his opinion, the telephones of the country were in the hands of those who had not done justice to the marvellous inventions which they had at their disposal, and to show that it was excessive in its expense, and not efficient, he said that it had not reached the point of development which it should have reached. He was not altogether in favour of a Government monopoly, although he thought the Post Office were unquestionably right in regarding the telephone service as a hand maiden of the service for which they were responsible. However, he also considered that it was possible the telephone service of the company might get to such a pitch that it would even be difficult for a department like the Post Office to control it. In his opinion, the Post Office ought to have charge of what he might call the artery system, but with regard to the capillary system—the network of wires over the country—it might be beyond the powers even of so great a department as the Post Office, and it would be wise to leave that entirely in the hands of private persons. He saw no difficulty in the system of royalties on various scales which would prevent loss to the Post Office. He also thought that there were two forces acting to prevent the development of the telephone. The Post Office in the past had prevented it by every means in their power, inasmuch as it would compete with their services, while the other cause was found in the fact that the telephone charges were excessive, and the service itself was a monopoly. In 1890 a society was founded for the protection of telephone users, and this was followed by some correspondence in the papers and an article by the Duke of Marlborough. In 1892 the Pioneer Company was brought out with the object of raising capital for the working of the New Telephone Company. The company was brought out by the Electrical and General Investment Trust Company. In 1891, he was approached by the Duke of Marlborough with regard to a plan he had drawn up for a telephone service in London. It appeared to him that the telephone service in London had grown up in an entirely haphazard manner.

The Chairman: Will you give the Committee an indication of the general principles of laying out the system in London?

Witness said he would begin by saying how he would not do it. When he put up an exchange, he would certainly endeavour to keep that exchange for the service in the area in which it was established. The process of telephone extension in London had hitherto been that an exchange was established, and then everybody was connected, and the result was they had a network of wires round the exchange, which must in the end lead to confusion. They thus had a huge number of subscribers brought to one point capable of communicating with one another who did not want to, and additional expense was brought about. In other words, there was no selection of the *clientèle* of the exchange. Up to the present time, the effect in London had been to bring everybody within the 630 square miles, which the National Telephone Company boasted it had, into communication with each other.

The Chairman: Will you please explain your system?

Witness said he would begin with the City of London, which was the most difficult. He pointed out to the Duke of Marlborough that the placing of the wires underground was probably one of the most difficult operations in the world. He knew as much of the streets of the City as the engineer himself, and he told him that one great central exchange for the City was simply an impossibility, because it was impossible to lay down radiating from one centre a sufficient number of tubes to carry the service which would probably be required. In order to meet that difficulty, he proposed to establish eight telephone exchanges in the City at different points, and when it was suggested that eight points were not as good as one, he explained that there was no more difference in eight exchanges in different points of the City than there was in eight exchanges in eight rooms in one house. The Duke of Marlborough saw the force of the argument, and he asked the City of London Electric Lighting Company, to which he (witness) was then engineer for the laying down of their system of mains for the distribution of electric light, to put in tubes which might be called spare tubes—to put those tubes in the same trenches to meet a demand in the event of the Commissioners of Sewers approving of their use.

Sir Charles Cameron: We have been told the electric lighting company surreptitiously laid down the tubes. It has been described as being done in an underhand manner?—There was nothing surreptitious in it. I imagine the streets of London were never disturbed as they were in 1891 and 1892. Anyone going or coming could have seen the number of tubes which were being put in, and, moreover, a return of that number was weekly, if not daily, sent in, not only to the engineer of the Commissioners, but also to Mr. Preece, of the General Post Office.

The witnesses of other bodies say the tubes were laid surreptitiously, and you tell us it was done in an open manner?—Of course, the company did not say the tubes were ultimately destined for the telephone, but they were laid down as spare tubes.

Lord Stanley: Without the request of the Duke of Marlborough, would those tubes have been laid. I mean without an understanding existed?—Let me answer the question in this way. I was a very strong advocate, when once the streets were open, of putting all the tubes we could in. If my advice had been taken, these tubes would have been laid down without any suggestion of the Duke of Marlborough. There was no doubt he had the idea in his mind that they might be used for the telephone service.

The Chairman: There was no authority for laying down tubes other than for the electric light company?—No.

And therefore, so far as these tubes were laid down for telephone purposes, it was outside the permission of the Commissioners of Sewers?—Yes, that was so, as far as the telephonic service was proposed.

Sir Charles Cameron: But permission would have been given for these tubes to be used?—I have not followed the correspondence between the company and the Commissioners, but I think it is a good thing they were laid down.

You think there would be no difficulty in getting the permission of the City authorities?—No; but the company did not absolutely bind themselves to lay the tubes for telephone purposes, and, in fact, many of them have been used since.

By Mr. Benn: There was no reason why there should not be underground wires if those tubes were used.

Continuing, Witness said 147 miles of 2¼-inch tube was laid, capable of holding 12,500 miles of twin conductors, and the value of the tubes was given in the reports of the City of London Electric

Lighting Company at £69,000. There was no doubt that the company went to that expense largely in view of the proposal of the Duke of Marlborough to utilise the tubes for telephonic purposes, if permission was given. The cost of twin wires would be £80,850 when drawn into those tubes, giving a total of £149,850, or £1,020 per mile. Each twin conductor would thus cost, when laid, £12 per mile, and the underground conductor of each subscriber would cost £5 8s. 6d., if they had 28,000 subscribers, for which that system of tubing was capable of making provision for. That was within the square mile of the City. He added to that for overhead work of carrying the wire into the subscriber's office the sum of £1 14s. The equipment and putting up of subscriber's apparatus, £4 10s., and the share of the cost of the exchange, £2 10s., making a total outlay at cost price of £14 2s. 6d. per subscriber in the City of London. Mr. Preece estimated the cost at £55 in London. The eight exchanges, which would have 3,000 odd subscribers each for the City itself, would be capable of serving subscribers outside the area of a distance of three-quarters of a mile, and they would then have the nucleus of a system in existence to serve 50,000 subscribers. The tubes were not laid outside the City yet, but they could be more easily laid. He thought Mr. Preece, in his estimate had omitted one or two points, and had exaggerated one or two points in regard to the switchboards. He thought the difficulty of numbers in an exchange could be avoided. If they took the Lancashire and West Yorkshire district with its numerous exchanges, and squeezed it together, it would be like London. So if they subdivided London, each exchange would serve its particular area, and tolls could be paid for an extended area. Then as to the difficulty mentioned by Mr. Preece of the Post Office having to keep lists for the connection of several systems, he could not see any difficulty, because the Post Office would simply have to put the wire through from one system to another. He thought it would be one of the most complicated things in the history of telephony for the Post Office to work the trunk wires. One of the great reasons for moderate charges in local areas was that the telephone might reach a class of persons not hitherto reached—not only agriculturists but small tradesmen also. The Pioneer Company was formed for the purpose of providing capital for the New Company, which was promoted for working telephones throughout the United Kingdom. The society for the protection of telephone users was registered as a limited liability company, and entered into an agreement with the New Telephone Company, which promised a better service than the old company. They agreed to put up wires on approval, and no doubt it was a good thing for telephone users. The National Telephone Company took up £244,000 of its capital, and the promises had never been fulfilled. In 1890 he was asked to go to Manchester and inspect the overhead wires of the Mutual Telephone Company, and he became aware of the position of the company. Their capital was £100,000, and they had called up and spent about £36,000 to establish the system in Manchester. The rate charged to non-shareholders was £6, and to shareholders £5, and there were about 2,500 users of that system and about 2,800 users of the National system. The National charged £10 a year, and he believed the rate came down to that. The Mutual was entirely a twin-wire. He did not hear any complaints from the subscribers of the Mutual of their being debarred from going on the National lines. The Mutual became transferred to the National, but the two separate systems were being kept at work He was a member of the committee which dealt with light railways, and he dealt with a large area of purely agricultural districts, and when the question of light railways being an assistance to agriculture was first mooted, it struck him that the telephone ought almost to take precedence of it in purely agricultural districts, and with that view he took a sample county, purely agricultural, and made an estimate of what the cost would be to establish call boxes at every village and hamlet in that county, connecting them with market towns, and, of course, with the Post Office. He felt that would meet a want. He took pains to inquire amongst the agricultural and tradesmen class, who were the backbone of agricultural life, and although the idea was new to them, there were many things in which the telephone would be of great assistance to them. The village tradesmen could communicate with the market town; the farmer would be able to know as to moving produce by communicating with the salesman, and it would also be useful in regard to the migration of labourers about the farms, and many other things. He estimated 29 exchanges in his county, with 450 call stations in villages and hamlets, at a total cost of £48,305. He took it that the Post Office would quote a low price for wayleaves. The outgoing would be £12,181, and if the charge was 2d. for every talk within the county, they would earn that if the talks brought in a gross revenue of 1s. 11d. per day. That would be 12 talks on an average. Those figures were very much below the rates at which either the Post Office or the Telephone Company would calculate the cost of construction. He assumed the work would be undertaken by the County Council. If it could be shown that it was an advantage to agriculture, and that there would be no charge on the rates, it would be worth their while to establish the system. He assumed that there would be nothing for wayleaves, and the wires and insulators would be of the kind used on the Continent. He meant permanent military telegraph line, which would last as long as the Post Office lines. He did not provide for twin wire, and he did not agree with Mr. Preece that no system could be good without twin wires. In Norway groups of farmers provided themselves with exchanges.

Sir Charles Cameron: That is a strong argument for giving licenses to county councils.

Witness said he thought it was, and he believed if licenses were granted, some of the councils would embark on the scheme if it would be an advantage to the farmer's. He thought county councils should be encouraged to take it up. As a matter of fact, it would bring the farmer into communication with the rest of the kingdom. His estimate did not make any allowance for royalty. He thought the Post Office would not impose any royalty on anything for the benefit of agriculture, but the payment of royalty would only require two or three more talks. A great deal of difficulties had been pointed out with regard to intercommunication when the systems were in the hands of the municipal bodies in different towns, but he doubted if the complications described would result. The development of the telephone, in his opinion, had been blighted in every way; it had never had a chance. It was less developed in the United Kingdom than anywhere. He thought London was especially badly off, and he trusted the Post Office would buy it up and remodel it. He thought that Mr. Preece exaggerated the question of the increase of cost in the telephone exchange in proportion to the increase of subscribers. It was true the cost increased, but not in the ratio suggested. Mr. Preece was a great expert in long distance telephony, and applied his experience to short distances, which made the deductions exaggerations. He thought there might be a classification of users, and deferred messages over the trunk lines taken at a cheaper rate.

Mr. Penn: You say you have devoted attention to London, and have got out a plan for a telephone service in London showing 100 exchanges. For how many subscribers do you provide in that plan?—About 2,000 per exchange.

Do you anticipate any difficulty from such an enormous number of subscribers?—No; because those subscribers would be classified.

What is the present total for London?—Under 10,000.

Do you think eight exchanges would be sufficient for the City?—Yes; I do not know the number now.

The point I want to get is this—whether you are in favour instead of this excessive centralisation which is said to be difficult and eventually prohibitive—whether you are in favour of multiplicity of the exchanges instead of centralisation of the system?—Yes.

Further examined by Mr. Benn, Witness said the cost of laying tubes for a radius of three-quarters of a mile outside the City could not be so great as in the City. He had not worked out what the cost would be for the area of the County of London. Taking the City, and estimating 28,000 subscribers, the difference between his estimate and that of Mr. Preece was something like £840,000. He did not know in the least how Mr. Preece got his figures. He believed the Mutual Company, in Manchester, was successful, but he thought a service could not be worked for the same in London. Dividing London into regions, he thought a charge of £8 a region would be reasonable.

Lord Stanley: So that if a man lived in the West End of London, and wanted to communicate with the East End, he would have to pay?—He would have to pay something.

Mr. Benn: Supposing you had an Islington region at £8, if a subscriber wanted to get into communication with another region, he would not have to pay another £8 a year?—No, there would be an increased subscription, or a system of tolls.

Further examined, Witness said that if the County Council devised such a system to meet the wants of the small tradesmen, he saw no reason why it should interfere with the proposed arrangement between the Post Office and the National Telephone Company. The tradesmen were not likely to be touched by the present high tariff. He thought the time had come when such a system would be a great feeder to the Post Office.

By Lord Stanley: He would divide London into six areas, and put an exchange in each, and not run wires a mile or two into a neighbouring area.

The Chairman: The subscriber of £8 to one exchange in the City would only be able to speak to one-eighth of the City?—I would classify between the subscribers; it would depend on the value of the service.

Mr. Grant Lawson: The National Company did not call you in about laying out London?—No.

But the New Company did?—Yes.

So you prefer your own system to the one the National Telephone Company has adopted?—They have no system.

Well, you prefer your system to what they are doing?—Yes.

On the principle that every father prefers his own child?—Yes.

Replying to Mr. Tully, Witness said he considered that it would be a wrong policy for the National Company to adopt to raise prices in one area to enable them to compete in another in the event of municipal competition. He thought it would lead to their earlier death. He should think local bodies were the best competitors.

In reply to Mr. Snape, Witness said he thought the sooner the telephones were bought up by the Government the better.

Sir James Ferguson: Do you anticipate that municipalities or private companies would feel themselves safe in expending money if they are at the mercy of the Post Office in 1911?—They would have to provide a sinking fund to cover 16 years.

The Chairman: Your plan is different to the National Telephone Company for supplying a service to London?—Well, I think they put their exchanges just as they want one.

You would divide up London into regions where you would have special charges?—Yes.

Do you know any other town in the world where that is done?—No; there is no town like London.

Therefore you differ with the telephonic companies in every town in the world as to the plan?—I cannot tell whether New York or Paris have modelled their districts for the future. In Paris they could serve 30,000 subscribers.

But they have a uniform charge?—Yes.

Because I suppose it meets the views of the telephone users?—Yes.

And I assume the National Telephone Company have adopted a system they think will meet the needs of the telephone users?—I have no doubt.

But you think they are wrong?—Yes.

You are the solitary advocate of regional changes?—I hope I am not.

Did you take into your estimate the cost of building?—No; I understood that Mr. Preece excluded the building of exchanges.

Did you take into account junction wires?—Yes.

When you served under Mr. Preece, did you find his estimates correct?—Yes.

You adhere to your opinion that £15 would supply the service?—Yes.

With regard to the agricultural system, you do not propose to charge a subscription?—No, only toll.

And you suggest the County Council start the system without any guarantee?—Yes.

You calculate that the 12s. per week per call station would meet the entire cost?—Yes.

How much would you allow for the salaries of officials?—I allowed 3s. 6d. for each office.

And you think you would get the farmer to make use of this, with all the danger of his conversation being overheard when prices were being quoted?—That is a defect of the telephonic service.

I understand that the Telephone Users' Protection Association have brought no action with regard to the agreement?—None that I know of.

Is that because the National Telephone Company have given them satisfaction?—I cannot say.

And I understand you are generally in favour of competition not only in London, but elsewhere?—Yes, licenses should be granted.

Notwithstanding that there would be waste of capital?—That would not matter.

And that waste of capital means increased charges?—I do not think it does.

And notwithstanding that competition in the past has invariably led to amalgamation?—Might I answer by saying competition has never existed. There have been unsuccessful attempts by various persons to compete, but they were always miserable failures.

But still it led to each company being swallowed up?—Yes.

And don't you think that would happen again?—No; I do not think so.

Do you think the charge of £17 is unreasonable for the service given?—If London was telephoned in the way it should be, then it would be a reasonable charge. But I think it is a large sum for what people do not want.

But do you think that for the facilities given the charge is an excessive one?—No.

And I suppose you would say that £10 is not an excessive sum for the large provincial towns:—No; I can't say that it is.

The committee then adjourned till the following Tuesday.

Mr. Arnold Morley (Postmaster-General) presided over the sitting of the Select Committee of the House of Commons inquiring into the working of the telephone service on Tuesday.

The Hon. G. J. Ward, Postmaster-General of New Zealand, and treasurer of that colony, stated that he had held the first office for five years, and had had practical experience of the work of telephones. In New Zealand both the telegraph and the telephone were in the hands of the State, and no one but the State could introduce either. There had never been any competition in any sense. The telephone had worked very successfully, and its development in a sparsely populated country was very marked. When they first started they had 116 subscribers, and now they had 5,000. That included the whole, both urban and rural; and the percentage was one telephone to every 120 inhabitants; the percentage of urban as against rural subscribers was about four-fifths urban. With one or two exceptions, they had single wires everywhere. They charged a subscription of £5 per annum, and £1 entrance fee for business purposes within half a mile of the exchange, and for private houses within one mile. Beyond those distances they charged £2 10s. per mile extra. Anyone requiring an instrument beyond the distance of two miles had to enter into a guarantee to keep the instrument for five years. That was the result of the very low charge, for they could not put up costly wires without the guarantee. They made no difference in the charge for five years. They had one central exchange in each town to which the call offices communicated. The total cost of the system up to the end of the last financial year was £104,500, and the total earned by the system £183,800, so that the earnings exceeded the cost by some £83,000. They provided for interest and depreciation 10 per cent. per annum, so that the net earnings of the telephones were £54,082. Under the head of costs they charged everything. Rental of buildings was charged, but, as a rule, they did not pay rents; the buildings belonged to the Government, and therefore there was no charge.

The Chairman: Have you gained any experience as to the question of centralisation or the sub-division of exchanges?—Yes; even with our small system we are opposed to the centralisation system. In the case of Wellington, where there is a considerable number of subscribers, we propose to build another exchange a mile and a half distant from the existing one, and connect them with a trunk wire.

But the subscribers will have the right to speak to all parts of the area at the same rate?—Yes; our subscription is a low one, but I think it only right to say the average cost of our connection is very small.

Replying to Sir James Ferguson, Witness said that the construction of the Post Office buildings was not altogether paid by loans. Last year their total expenditure was £450,000, and £250,000 of their revenue was put to the Public Works Fund. The Post Office works came out of that fund. They could take it that the cost of their buildings and lines came rather more out of revenue than capital. The largest number of subscribers were on the Wellington exchange. On March 31st, 1894, there were 872 subscribers, and now he supposed there were about 1,200. There were about 25 exchanges in the country, which gave them an average of 200 subscribers per exchange. Practically the telephone service in the rural parts of the country was looked upon as an auxiliary to the telegraphic service. The longest line used by subscribers was about 100 miles, but they could speak a distance of 150 or 180 miles.

Do you consider your telephone is generally efficient and the sound clear?—It is an efficient service, but a single wire system of course is not as good as a metallic system; but we have very few complaints.

What weight of wires do you use for trunks?—I cannot tell you that.

By Mr. Benn, M.P.: After a certain distance it became a most costly service. The adjustment of charges decidedly benefited those who only required a limited service. He could not give any information as to the proportion of messages coming from the £5 service, but anyone visiting the colony would find that the telephone was used unremittingly day and night.

In this country we have one tariff for long and short service, so that the subscribers who only require a limited service have to bear the burden of those requiring a lengthened service. Is your tariff not a great saving to those who only require a limited service?—Yes, it is. Before we had the low tariff we only had a very meagre subscription list compared with what it is now. When I became Postmaster-General we reduced our subscriptions by practically one-half, and the result of that reduction is that it has made up more than the previous revenue, and that is got by the people living within the limited area.

The Chairman: It is not a limited area in the way Mr. Benn means. Some subscribers pay £5, some £6, and so on; but every subscriber has the right to speak over the whole area. The difference in price merely means the difference in the cost of the line?—Yes.

It does not mean a limited area over which they can speak?—No.

Mr. Benn: On the question of centralisation, you stated, I think, your experience tended in the direction against centralisation, even in a town of 70,000 inhabitants?—In New Zealand our system of telephonic communication is very rapid. We want to maintain that speed, and rather than have a large exchange with an excessive number of subscribers, we believe in having two exchanges with a limited number of subscribers.

Does your experience show that sub-division of exchanges tend to speed?—It does.

Sir Charles Cameron: How about the trunk wires?—If non-subscribers want to use the service, they pay 6d. per six minutes for a distance of six miles. If beyond six miles 1s. Subscribers pay 6d. for six minutes, and they are switched through to more than one exchange for that charge. In addition to the subscription of £5 per annum, anyone is entitled to an additional instrument they like for £1 per annum extra each instrument.

Further examined by Sir Charles Cameron, Witness said they had used iron wire, but there was an objection to that, inasmuch as there was a limit to the distance of talking. They did not use it now. They used the Blake instrument. He had used the telephone in London, and the delay was the only objection; but London was a large place. The instrument he used was a very clear one. In some of the Australian colonies there was a better service.

The Chairman: Have you any difficulties with regard to wayleaves?—No; none whatever.

So that charges of that kind which have to be met in this country does not apply in New Zealand?—No.

Every subscriber has exactly the same right to speak to another subscriber?—Yes.

And the difference in charge is merely that of the cost incurred by the State in connecting his house with the exchange?—Yes.

I understand you have not tried the multiple board system?—We have tried it, but even under that system we prefer to have more exchanges and trunk wires between exchanges. Our experience leads us to believe in sub-division.

Mr. Grant Lawson: We have the pole system almost entirely.

Mr. W. H. Dickinson, Deputy Chairman of the London County Council, said he wished to make a further statement. When he was last before the Committee, he stated that the service of the National Telephone Company was unsatisfactory, and complaints were made, and the Committee asked if he had any special evidence on that point. He reported to the Highways Committee of the Council, and they decided to send a circular to the users of the telephone service in London, and he was instructed to put the results before the Select Committee. The circular was sent out to the subscribers of the National Telephone Company, numbering 7,329. The circular was in the following words:—Sir,—You are probably aware that a Select Committee on the telephone service has been appointed to consider and report whether the provision now made for the telephone service in London and other areas is adequate, and whether it is expedient to supplement or improve this provision either by the granting of licenses to local authorities, or otherwise. The Highways Committee of the L.C.C., to whom the duty of procuring evidence on this matter is referred, being of opinion that telephone service in the metropolis should be rendered cheaper and more efficient, have submitted their views to this effect to the Select Committee, and similar evidence has been tendered by the Commissioners of Sewers of the City of London. The Committee of the Council are anxious to know accurately what is the opinion of the users of telephones in London as regards efficiency, and answers are requested to the following questions:—"(*a*) Is the existing telephone service of the National Telephone Company efficient and satisfactory to you? (*b*) If it is not satisfactory, in what respects is it unsatisfactory? (*c*) What suggestions (if any) would you make for the improvement of the service?" To that they received 2,536 replies, of which 555 subscribers expressed entire satisfaction; 1,981 were not thoroughly satisfied. The 1,981 were made up of the following numbers:—1,305 who expressed general dissatisfaction with the actual telephone service, 350 who were undecided in opinion as to suggestions, and 326 who expressed themselves satisfied with the existing system, but suggested improvements. The

answers were rather complicated from the fact that, at the same time, a circular was sent round by the National Telephone Company. The circular of the National Telephone Company asked whether the users approved of the London County Council taking over the service, and a good many replies were returned to the Council.

The CHAIRMAN: Did the 5,000 who did not reply to your circular send to the National Telephone Company?—I do not know. There were some forms of the company which came to us with certain words altered. In addition to that we had a certain number of letters. One states that "The service is scandalously bad and atrociously dear."

The CHAIRMAN: We can't go into that; it is very secondary evidence.

WITNESS: There were a few other letters came to us.

The CHAIRMAN: It amounted to this. Of 7,000 subscribers, 2,500 only replied, and 525 expressed complete satisfaction, and 1,981 were not thoroughly satisfied, and 320 of those expressed themselves satisfied with the suggested alterations.

The WITNESS: The desire of the committee was to ascertain the truth.

Mr. DICKINSON explained further that Mr. Bennett was ill and could not give evidence as to the cost of the system which the Council put into evidence. They would be glad to furnish the Committee with copies of a document giving the various prices charged abroad.

The CHAIRMAN said they already had that from Mr. Preece.

Lord STANLEY: I think the telephone company's circular went first.

Mr. BENN: Yes; they were the smarter.

(To be continued.)

CORRESPONDENCE.

Electric Heating and the Day Load.

I was rather disappointed not to find in your current issue some correspondence on Mr. Dowsing's article on electric heating, in your impression of the 10th inst. Mr. Dowsing once again raises the important question of the "day load." He points out very clearly, to my mind, that the quickest solution is to supply current for heating and cooking, and, considering the amount of indirect benefit, Mr. Dowsing must have been to the Supply Company by pushing in such a masterly way the sale of apparatus for heating, cooking, and other purposes, his opinion should be of some value. The charges of most supply companies for current during the day time are far too high for the majority of middle-class householders. Yet the companies continue to keep their plant idle during this time when they might be at work, and if earning only a little over works' cost it would be profitable.

Current at 3½d. per unit, though in most cases it could be supplied at less, would create a strong inducement to householders to give it a trial, leading in turn to more lights being added. I know from experience that even at 4d. per unit cooking can be economically done. It seems rather surprising that the "bold stroke" Mr. Dowsing mentions has not not been adopted before, it would without a doubt pay very soon. There are, I know well, many little difficulties to be overcome, but they are not insurmountable. The overlapping of the load curve would not be so serious as imagined, and could in the case of low tension stations be dealt with by the batteries.

The metering question is another point on which unanimity does not exist. The use of separate meters means another rent of from 2s. 6d. to 10s. (according to the size of meter and rents charged by the different companies) per quarter, and this I find is always a "thorn in the consumer's side." Mr. Wright's system at Brighton avoids this, the current all passing through one meter, the reduction to 3d. per unit *for all purposes*, taking place after the maximum current has passed for one hour per day. I do not say that this system would be applicable in all cases, but I certainly think it is as near perfect as any system I have yet seen. These are amongst the most important questions to be dealt with, and Mr. Dowsing might have given us in his article his suggestions for dealing with them. Anything conducive to the realisation of our hopes for a day load and cheaper current for day use would be beneficial, not only to the supply company and consumer, but to the wiring contractor.

B. H. Jenkinson, A.M.Inst.E.E.

May 20th, 1895.

Electric Traction Precautions.

Regarding your remarks *re* tramway accident in France, referred to under "Traction Notes" in your issue of the 17th inst., I think the disastrous effects which might have occurred, should impress upon our own engineers, when designing electric traction systems, the necessity of adopting the efficient and simple safeguard afforded them by the use of the electric brake as an auxiliary against accident when descending steep grades.

The method I refer to, is by the employment of two series motors on each truck, coupled in parallel, which, when current is shut off from the line, work on a closed circuit of their own, and by the magnetic locking of the motors which is the result, prevent the car from descending steep grades with dangerous velocity.

The method is very simple, can be applied without extra cost and has proved itself worthy of more general adoption. To my own knowledge it has been the means of promoting increased confidence of the public in electric traction systems after they have seen, heard of, or experienced cases where it has been successfully applied.

For instance, if the car is ascending a steep grade and the ordinary wheel brakes fail to act, the car will simply "back down" the grade by easy stages, until the driver can bring it more under control, no alteration of the reversing switches being necessary, they being turned for "up hill."

If, however, the car is descending and becomes unmanageable, the switches must be reversed for "up hill" before any brake assistance can be gained from the magnetic locking of the motors. To my own knowledge it has proved most reliable on some early systems of electric traction in the United States of America, and has been the means of preventing serious accidents, but to what extent it has been applied of late years I am unable to say.

Mr. Holroyd Smith, I believe, advocated the method some time ago, and Dr. Du Riche Preller in his paper before the Institution of Electrical Engineers on November 22nd, 1894, and in his reply on December 13th, 1894, referred to its adoption on the Zurich, Geneva, and Florence systems.

I personally think the matter is one which might with advantage be included in the Board of Trade regulations for tramway work, as an extra safeguard (where series motors are adopted) against loss of life.

Gus. C. Lundberg.

Information Wanted.

I am very much interested in the question of the employment of condensers in central stations, believing, as I do, that there is a large commercial future before them; and I have recently, in my searches, come across a specification of a condenser (communicated by Prof. Threlfall, of the University of Sydney, New South Wales) which will, in my estimation, prove the ideal condenser so long sought after by progressive central station engineers. I have, also, naturally obtained Mr. Swinburne's specifications, and I am in a quandary as to which is which and what is what! Material differences appear in the specifications in the prefatory excursions; and, on the whole, I prefer Threlfall's construction. Can you inform me if the latter's condenser is being manufactured, and by whom; or is there an amalgamation between Swinburne and Threlfall by which the former is manufacturing under both specifications?

My questions savours somewhat of conundrums; but we, in the profession, can always look confidently to you for assistance in dilemmas.

Enquirer.

[Mr. Swinburne tells us he knows nothing of Threlfall's apparatus.—EDS. ELEC. REV.]

Parfitt's Electric Lighting System.

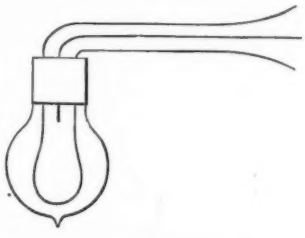
Having seen an article in your last week's issue on Mr. Parfitt's system of electrical distribution, I thought the following would be of interest to your readers.

When I had charge of the Ottawa Gas Company's electric light plant in Ottawa, Canada, 6 years ago (who then were lighting the public streets by means of arc lights and supplying same for shops, &c., but no incandescent lights), I had the opportunity of inspecting an opposition company's plant, "The Chaudiere Electric Light Company," which supplied incandescent lights only almost next door and using the same water power. Their plant consisted of about 6 250-light Weston dynamos, and they used the series multiple system.

The lamps in the buildings were grouped I believe so

many in series and then joined on to the mains in parallel. The charge for current was 3 cents per night, up to 1 a.m., per 16 C.P. lamp.

When I was working for the Thomson-Houston agents, the Royal Electric Light Company in Montreal, about 8 years ago, I also had the opportunity of seeing the plant which lights up the Lachine Canal and the Wharves or Harbour in Montreal. The station is built on the canal and is run by water-power from the same source, and consisted of, at that time, one 50-light dynamo, T.-H. system (which was used for lighting the harbour up with 2,000 C.P. arc lamps), and one or two 400-light Edison dynamos which were used for lighting up the canal banks by means of incandescent lamps in series. Each lamp had a small cut-out over it in the shape of an electro-magnet, so that if a lamp broke the magnet came into play and completed the circuit. I do not remember actually seeing the particular lamp you speak of, but I remember well having a discussion about the same thing in the works in Montreal when Mr. Fred. Thomson made me a sketch similar to the following :—



He explained to me that sometimes the cut-out would not work, and that this lamp was invented so that if the filament broke and the cut-out would not work a short circuit was made between the centre terminal shown in sketch and one of the outer ones which made the magnet more powerful, and thus completed the circuit.

Charles Rettie.

A Protest.

I regret to learn that my views have disagreed with "Another Student;" but will he point out where, in the letter you were good enough to insert in your issue of the 10th inst., I am supposed to "attribute unworthy motives to the authors?" Nothing was farther from my thoughts when I wrote to you; and, as you, sir, have taken the matter up, I am content to leave "Another Student" to the tender mercy of yourself and of the "professor" whom he goes out of his way to belittle.

Student.

LEGAL.

Woodhouse and Rawson United, Limited.

In a debenture holder's action taken by a Mr. Wood against this company, heard on 16th inst., application was made on behalf of the Official Receiver and Liquidator for liberty to take proceedings against directors of this company in respect of alleged misfeasances.

Mr. Howard Wright, in support of the application, said that it had been suggested that a meeting of the debenture holders should be summoned to consider the matter, but it seemed doubtful whether the Court ought to be guided entirely by their opinion. According to the view of the Official Receiver it was estimated that there would be a deficiency of not less than £150,000, and it was extremely improbable that any one but the debenture holders would be benefited by the misfeasance proceedings if they were successful. This case was different, however, from that of the New Zealand Loan and Mercantile Agency Company, because in that case the Court had to consider the injury which might occur to the new company if misfeasance proceedings were taken in the winding up of the old company. In the present case there was no new company.

Mr. Justice Vaughan Williams said that in a debenture holder's action, having regard to the representative position in which the plaintiff stood, care ought to be taken to see that if the view of the debenture holders was ascertained, it should be a view which was not improperly brought about by outside communications. But if the unbiased judgment of the debenture holders was obtained and was against the misfeasance proceedings, his Lordship thought he ought not to allow the proceedings to be taken. He thought it would be better to call the debenture holders together.

Mr. Macnaghten, for the plaintiff, said that some disinterested person ought to be directed to preside at the meeting, and suggested that Mr. Leslie, the receiver in the action, should be appointed to preside, as Mr. Squire, whose name had been suggested as chairman, did not wish to do so. The Official Receiver was the person now asking that proceedings might be taken and could scarcely be described as an entirely disinterested person.

Mr. Method, for Mr. Squire, said that his client did not seem to be the right person to act as chairman as he was a trustee for persons to whose interests the question involved was not very material.

Mr. Justice Vaughan Williams, after some further discussion had taken place, said that the Official Receiver must be appointed to preside. His Lordship said that, although it might be thought improbable that anything would be obtained for the unsecured creditors yet one could never be quite sure that this would be the result. If the debenture-holders arrived at a deliberate and honest conclusion that proceedings ought not to be taken, his Lordship would be very glad. But if their conclusion was based on the fact that they thought it a pity that there should be the scandal of subjecting respectable persons to proceedings, that ought not to be allowed to weigh much. Mr. Leslie must not suppose that because his Lordship had not appointed him to preside he had intended to cast the slightest reflection on him. His Lordship thought that under all the circumstances it would be better for the Official Receiver to preside. All the debenture-holders must be summoned to attend one meeting, but the voting must be arranged to take place in such a manner that it might be known how the persons belonging to the different classes of debentures had voted.

Mr. C. E. E. Jenkins, for Mr. S. Pope, Q.C., said that he hoped no undue advantage would be taken of the discussion of the matter in Court, and that no adverse views would be arrived at.

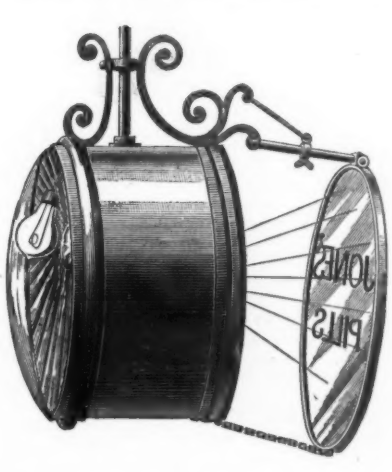
Mr. Justice Vaughan Williams said he was sorry that he could not ask Mr. Pope to preside at the meeting himself; and his Lordship would not say that if he had formed any adverse views.

The meeting will probably take place about Whitsuntide, and voting by proxy will be allowed.

BUSINESS NOTICES, &c.

Ready.—The Universal Electrical Directory. This directory for 1895, which is on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter. Price 4s.

An Advertising Shop Lamp.—We give below an illustration of a new shop lamp, which is estimated to commend itself to business men who consider advertising to be the soul of business. The fitting (which is weather-proof) is constructed in neat style and



may be described briefly as follows: The side nearest the shop window has a powerful reflector and acts as an illuminant, as is the case with ordinary lamps. A 50 or higher C.P. lamp is used and through the medium of lenses projects an advertisement, on to a ground glass or opal screen fixed at the back of the lantern, which is visible from the street. This advertisement, which may be either pictorial or plain lettering, automatically changes every half minute, or at longer intervals if desired. The mechanism for producing this effect is electrical and is actuated by a very small part of the current (either alternating or direct), used by the illuminating lamp. No appreciable effect of the magnets used in the mechanism is felt by the main lamp, as this is counteracted by a small shunt resistance. Further information can be obtained from the General Electrical Company, Limited.

Bankruptcy.—An adjourned meeting of creditors was held last Friday at the London Bankruptcy Court, under the failure of J. T. Todman, electrician, lately carrying on business at 112, Queen Victoria Street, E.C., and 36, Bermondsey Street, S.E. The debtor commenced business as an electrical engineer in 1884, at 41, Queen Victoria Street, and Budge Row, E.C., in partnership with Mr. J. T. Mayfield. The debtor, who has recently returned to this country, attributes his failure to liabilities incurred as managing director to a company, and to liabilities upon accommodation bills. The Chairman said the meeting was adjourned from a former occasion to enable the debtor to file the usual statement of affairs, and to submit a proposal. No offer had yet been lodged, but the accounts showed total liabilities £1,840 10s. 2d. (unsecured £725 3s. 10d.), and assets £207 7s. 2d. On behalf of the debtor it was intimated that he still hoped to put forward an offer of not less than 7s. 6d. in the £, and with that view a further adjournment of four weeks was granted.

Change of Address.—Messrs. W. J. Wells & Co., formerly of Worth, Crawley, Sussex, have removed to Smallfields, Horley, Surrey, where they will continue to manufacture steam, gas and oil engines, and various electrical apparatus. We have received a list of engines, &c., as made by the firm.

Detachable Ball Fittings.—The following illustration shows a patent detachable ball fitting manufactured and supplied by The General Electric Co., Limited, which will be found a very useful electric lighting accessory. A difficulty has hitherto been experienced with multiple light fittings (*i.e.*, those with a number of lights fitted

under a large opal shade) through inability to remove the shade for cleaning purposes or replacement, without disconnecting and removing the lampholders. By using this patent ball fitting the difficulty is obviated, as the ball unscrews in the centre, the bottom half having the lampholders attached to a ring and centre stud, and the flexible wire is fitted to two plungers on the top half, similar to the ordinary lampholder, and on screwing the two halves together perfect contact is made. The diameter of the ball is such that a shade with 3¼-inch gallery will pass over top half without any difficulty.

Dissolution of Partnership.—Messrs. H. F. Jackson and T. A. Kerr, both of 85, Queen Victoria Street, E.C., carrying on business as electrical engineers at that address as Whittaker & Co., have dissolved partnership by mutual consent, as and from the 31st day of March, 1895. All debts due and owing will be received and paid by H. F. Jackson.

Lahmeyer Dynamos.—Mr. Mensing, who previously supplied the Lahmeyer dynamos for Mr. Wm. Whiteley's electric light installation, has received the order for two 60 kilowatt dynamos to be added to the existing plant.

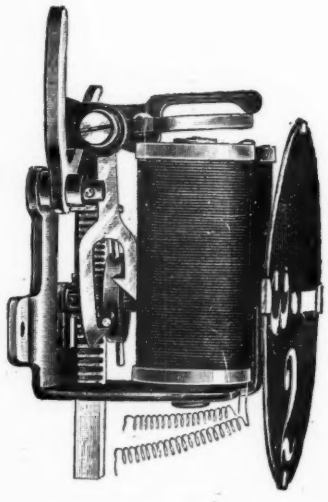
Madras Electric Tramways Company, Limited.—A petition for winding up this company was presented at the Courts of Justice on 15th inst., and is directed to be heard on 29th inst. The petitioners are the Commercial and Land Mortgage Bank, Limited, creditors of the company.

The "Svea" Glow Lamps.—Messrs. J. C. Lyell and Co., of 55, Victoria Street, S.W., have been appointed sole agents for London, Birmingham, and the South of England districts for the "Svea" lamp, made by the De Laval Lamp Company, of Stockholm. We have received a May price list of the lamps, also copies of curves showing the variation of energy and of efficiency of light, both testifying favourably to the "Svea" lamp.

Mica.—We understand that Mr. Archibald Campbell, of 28, Gray's Inn Road, W.C., has secured a contract from the Admiralty for mica, on behalf of Baxters & Macdonald, Dundee.

Re J. G. Statter & Co., Limited.—Mr. Frederick J. Tingle, of 110, Cannon Street, E.C., the Receiver and Manager in this company, has sent out a notice giving particulars of stock of switches, cut-outs, wall sockets, dynamo guards, cable, casing, brackets, pendants, and other electrical appliances and fittings, being the surplus stock of the Works and Contract Departments of the above company, "which are offered to the trade at exceptionally low prices, in order to facilitate the completion of the winding-up." The goods will be on offer, and can be seen at 68, Victoria Street, S.W., until Saturday, June 15th next, and inspection is invited. The business of the Works Department has been sold, and is now under the management of Mr. J. G. Statter. Messrs. Leonard Milne and Henry Foote are making arrangements to take over the goodwill of the Contract Department.

Triplex Indicator Movement.—A new indicator movement has recently been patented and brought out by the International Electric Company, of 55, Redcross Street, E.C., which they call the "Triplex" movement, and which, as its name denotes, allows of three different signals being given with the same movement. It is constructed on the principle of their Universal Bell, described in this paper some 10 months ago. While hitherto a pre-arranged code of signals has allowed of making use of the same bell to give different signals and to call different people, the want of a recording instrument that would show correctly the number of calls has been greatly



felt. The triplex movement marks permanently (until replaced) a signal denoting clearly who has been called, so that when the bell has been rung once, twice, or three times, each different signal attached to the same movement will appear consecutively and remain visible. Indicators fitted with this movement could with advantage be used on board ship in the ordinary way, as the "Triplex" has a perfect locking arrangement, only dropping when a current is passed, and not in any way affected by the rolling of the ship, even in the severest weather. From the illustration given, an idea of its construction, &c., will be obtained.

The European Sims-Edison Electrical Torpedo Company, Limited.—A general meeting of this company will be held at its office, 9, Fenchurch Avenue, E.C., on Wednesday, June 19th, 1895, at 2 o'clock in the afternoon, for the purpose of having an account laid before them showing the manner in which the winding up has been conducted, and to execute business usual at such meetings.

Theft.—The clerk who was charged a few weeks ago with stealing about £237 from the Brush Electrical Engineering Company, in whose employ he was, has been sentenced to 18 months' hard labour.

The Walsall Electrical Company v. The Walsall District Iron Company.—In this case, which was heard at Walsall last week, the plaintiffs sued for £64 16s. 11d. for putting down an electric installation for lighting purposes at the defendants' works. The plaintiffs declared that the system was absolutely satisfactory when handed over to the defendants, but that to meet the complaints which were made they from time to time made alterations which were not strictly within the provisions of their contract. Dynamos to which particular objection was taken were removed from the defendants works and put up on the plaintiffs' premises, where they were at that moment doing, and had for some time been doing, with perfect accuracy work identical with that required at the defendants' works. The defendants, on the other hand, contended that there had been a complete breakdown. To that the plaintiffs replied that whatever irregularities there might have been were entirely due to want of care in many ways on the part of the persons employed by the defendants to work the plant. After the case had proceeded for some time a settlement was arrived at.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Northern Electric Supply Company recently applied to the County Council for sanction to an application to the Board of Trade for an electric lighting provisional order. They have referred the matter to the District Council.

Aberystwyth.—Mr. A. H. Preece, to whose appointment we referred last week, has tested the electric light here, and found it satisfactory.

Ashby-de-la-Zouch.—The Gas Committee has recommended that the gas contracts be continued up to March, 1896, and that in the meantime the Council take into consideration the question of the lighting of the town with electric light.

Bolton.—The engineer last week submitted a tabulated list and analysis of the tenders for the supply of engine and alternators in the extension of the electricity plant. The tender of Messrs. S. Z. De Ferranti for the supply of the alternator was accepted, as was also that of Messrs. Hick, Hargreaves & Co., for the engine, subject to certain details being carried out to satisfy the engineer. A Local Government Board inquiry is to be held regarding the application of the Corporation for the sanction of the Board for borrowing £17,300 for electric lighting purposes.

Brechin.—The Board of Trade have written to the Police Commission intimating "that they are not to proceed with the Brechin Electric Light Provisional Order."

Bury St. Edmunds.—A local firm (Messrs. O. and J. E. Richardson) are putting down electric lighting plant for the purpose of supplying their premises, and having been asked by tradesmen on the opposite side of the road to supply to them also, the firm has asked the Council's permission to the laying of a pipe across the road for the purpose of carrying a cable.

Bristol.—A Local Government Board inquiry was held yesterday regarding the Council's application for sanction to borrow £10,000 for the purpose of electric lighting, and other larger sums for various purposes.

Coventry.—The high tension mains are to be extended from the bottom of Hertford Street along the Warwick Road, with two transformers and supply mains according to a plan which has been submitted.

Dover.—The inhabitants of Snargate Street are stated to have memoralised the Town Council for electric lighting in their street. Their memorial is receiving the consideration of the Council, who are in communication with the electric light company.

Fareham.—The ratepayers are very reasonable in their desire to end the quarrel that has for a long time been in progress between the Electric Light Company and the Council, and to stop all likelihood of litigation. They are taking steps to carry out their purpose.

Hebden Bridge District.—Mr. Blackburn, A.I.E.E., is engaged putting down an installation of about 300 lights, 16 and 25 C.P., at Nanholme Mills, Eastwood. The machine is one of Crompton's compound wound, speed 700, output 20,900 watts. The same gentleman has in hand an extension of the electric light plant at Bridge Royd Dyeworks (Messrs. Moss Bros.). A Crossley's engine has for 2 years been run with water gas, the engine running both machinery and dynamo.

Huddersfield.—The Minutes of the Electric Lighting Committee, which were adopted by the Council on 15th inst., showed that the further amounts likely to be required for these works were £15,000 for buildings and £35,000 for general purposes, and it was recommended that the Town Clerk take steps to obtain borrowing powers for £50,000. The recommendation was approved by the Council.

India.—Messrs. Lowdon Brothers have obtained an order to light three jute mills in India with the electric light—the Samnuggur, the Titaghur, and the Victoria. There will be over 1,200 lamps in each mill. Mr. K. Lowdon, who is at present in India, has almost completed the fitting up of the Seebpore and the Howrah Mills with the electric light, and it is expected that the installation into the other mills will be ready before the lighting season, which begins about the middle of August.

Leyton.—A committee recommended the District Council to invite tenders for the electric lighting of the new public hall, the estimated cost being £1,250. The Council referred the matter back for details.

Liverpool.—At the Special Lighting Committee of the Council at Monday's meeting, the draft agreement to purchase the whole of the plant and rights of the Liverpool Electric Supply Company for the sum of £400,000, was considered. We underetand that the draft agreement was approved, and will be submitted to the next meeting of the Council, together with a recommendation that Parliamentary powers to carry it into effect be applied for forthwith. Should this recommendation be approved, a Bill will be at once introduced into Parliament, and, it is expected, will be passed during the present session.

Liverpool.—The electric light plant which has been put down at the Brunswick Station of the Cheshire Lines Committee by the Committee's own staff, supplies 65 arc and 350 incandescent lamps. Messrs. Mather & Platt supplied the machinery.

Lynn.—The Council has the question of applying for a provisional order to enable it to light the town by electricity, before it for consideration.

Morecambe.—A sub-committee of the Council has been appointed to negotiate for the purchase of the Electric Light and Power Company's undertaking.

Northampton.—A committee recommended that the Market Square be lighted with four electric lamps of 1,000 C.P. each, at an annual cost of £70, in accordance with the estimate of the electric light company. After a long discussion, the Council referred the matter back.

Perth.—The electric light installation, which has been fitted up at the Perth Waterworks by Messrs. Lowdon Bros., of Dundee, comprises an 8 H.P. steam engine, and an E.C.C. dynamo having an output of 30 ampères at 100 volts. The lamps are of 16 and 32 C.P. respectively.

In the new municipal buildings, provision is to be made for the introduction of electric lighting.

Peterborough.—The Town Council's powers under the provisional order for electric lighting expire in twelve months from July. We understand that circulars have been issued, and the replies are so satisfactory that the Council feel justified in pushing the work forward.

Portsmouth.—In connection with the electric light extensions, the committee have ordered one mile of earthenware pipes of Messrs. Jennings for conduits, at 2s. 11d. per yard. It has been left with the chairman to confer with Messrs. Kincaid, Waller and Manville as to preparing the specification for the extension of the electric mains, generally superintending the outside portion of the work, and to be answerable for its efficiency for six months after completion, at an inclusive fee of £315.

Southampton.—The Electric Light and Power Company summoned one of their customers the other day for cost of current consumed upon his premises and meter rents, in all, £8 odd. The defendant alleged that there was breach of contract on the part of the company in supplying a defective meter. The case was adjourned for a week.

The Electric Lighting Acts.—In the Commons the other day Mr. Bryce, President of the Board of Trade, said, in reply to a member, that the second section of the Electric Lighting Act of 1888 provided that local authorities might purchase the undertaking after the expiration of 42 years, or some shorter period if specified in a provisional order. The Board of Trade held that it was in the interest of London that the power of purchase should operate at the same time over the whole of the metropolitan area. To that policy the Board adhered.

Tunbridge Wells.—We learn that Sir Myles Fenton has just placed with Messrs. Drake & Gorham the order for the electric lighting of the Tunbridge Wells station of the South-Eastern Railway, the current being taken from the outside supply.

West Ham.—The Highways Committee recommended the Town Council to invite 12 of the leading electric light contractors to submit schemes and estimates for an electric light installation for the compulsory area mentioned in the provisional order, the corporation to find the capital, and the company to work the plant for a term of years to be agreed upon. The Council referred the report back.

Witton Gilbert (Durham).—The Parish Council has appointed an expert to report on gas, electricity, and oil lighting, in accordance with a letter of his addressed to the Council.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Brighton and Rottingdean Electric Railway.—During the week the Brighton and Rottingdean Seashore Electric Tramroad Company has brought out a prospectus inviting subscriptions for 353 £10 shares. The directors and their friends subscribed privately £16,470, out of a nominal capital of £20,000, leaving the above £3,530 for public subscription. This line, about which our readers have already heard a good deal, is to run from Paston Place, Groyne, Brighton, adjoining the eastern terminus of the present electric railway to Rottingdean. The line is about three miles long, and is laid along the seashore about 150 yards from the cliffs on concrete sleepers, and consists of a double line of steel rails, similar to those of an ordinary railway. Each pair of rails is 3 feet wide, and there is a distance of 13 feet between each pair. The car, which will be 45 feet long, will be carried on a strong steel framework; this framework will be 19 feet wide. It will run on 16 wheels, of which eight will be on one pair of rails and eight on the other, thus ensuring perfect stability and smoothness in running. The wheels and part of the framework will at certain states of the tide be under water, but the car will be sufficiently elevated to run at all states of the tide. The line is being constructed by the company without the intervention of a contractor. About two-thirds of the permanent way is already laid; the landing jetty at Paston Place, with waiting and refreshment rooms, offices, &c., is practically completed, as is also the jetty at Rottingdean, which has been made sufficiently large to afford a pleasant promenade. With favourable weather the whole of the line is expected to be completed and open for traffic this summer.

Bristol Tramways. — Communications have passed between the Electrical Committee and the tramways company with a view to utilising the posts in Old Market Street, which would carry the tramway wires for the purposes of the electric light posts, so as to avoid the multiplication of standards in the middle of the road at irregular intervals. It was resolved to let the matter stand over until the return of the surveyor from London.

Dublin Electric Tramways.—Surely the Dublin Corporation and the late London County Council must have been in clandestine communication, for the grandmotherly decision arrived at by the London body in regard to electric tramways on the trolley system will probably be followed by the Dublin folk, although not without a little more investigation than was given by the L.C.C. The Dublin Tramways Company have a Bill before Parliament. The promoters of the scheme desire to instal part of their system with electric tramways on the trolley-wire system, and as soon as this came to the ears of the Corporation, they held private meetings to consider the matter. The Lord Mayor is very favourable to the company's scheme, but though he presided at one of these meetings held *in camerâ*, a deputation was appointed to proceed to Belgium, Holland, Germany, and Austria-Hungary to inspect electric tramways and prepare a report in opposition to the company's scheme. About ten days were spent in Europe, and afterwards a strong report was prepared against the system. Subsequent to the issuing of this report, the Lord Mayor started upon an European tour himself, calling at Walsall on the way. He is now following the same route as the deputation took previously, and it is expected that his views will materially differ from those of the deputation. According to the Dublin *Sunday World*, the view of the Corporation is that, permitting the tramway company to obtain indefinite authority to introduce any system of electric traction they may like, would be conceding them more control of the public thoroughfares than any private company has a right to possess against the local authority, and the Corporation asserts its supreme right to dictate what may and what may not interfere with the use of the streets by the public. Consequently the Corporation desires that the Tramway Company's Bill should definitely specify the system of electric traction, and prescribe the exact amount of interference with the thoroughfares on equitable terms. The tramway company decline altogether to adopt the underground system of traction, as this would involve the enormous expense of taking up their entire rail system, so as to lay the electric wires in tubes under the rails; and they also state that the underground system has been adopted in very few places. While seeking new powers, the tramway company intend, we hear, to limit their first trial to whatever system they may arrange in consultation with the Corporation, to the Clontarf section of their system. If the Mayor has any supporters, and they stick manfully to their guns, they may yet be successful in dispelling the hazy atmosphere of prejudice which hangs over the council. Let them peruse the report of the Leeds Highways Committee to which we referred last week. They will find it interesting and healthy reading.

Proposed Tramway at Newcastle.—The Corporation of Newcastle has powers to lay down a tramway line by the City Road to the Ouseburn boundary. A proposal has been made by a responsible firm of electrical engineers to work the section on the overhead wire system, the same as is in vogue between Briggate and Roundhay Park, Leeds. It was proposed to start the line below the Arcade, but members of the Tramway Committee said that unless it was carried to about the central station it would lose much of its advantage, and further, its utility would have to be enhanced by going beyond the boundary of the city to Walker. Authority to do so would have to be got from the Walker District Council, and in regard to the extension to the station the borough engineer, while thinking well of the offer otherwise, said the overhead wire system through the intervening central thoroughfare would be most objectionable. A suggestion by a member that they should visit Leeds and see the overhead system at work there was negatived on the ground of expense.

Proposed Tramway at Rhyl.—The line, to which we referred last week as being suggested from Rhyl to Prestatyn, would be about four miles in length. The firm with whom the Corporation are now negotiating is Messrs. Alfred Dickenson & Co. We understand that the proposal is for an overhead scheme similar to the South Staffordshire Tramways.

TELEGRAPH AND TELEPHONE NOTES.

Coast Communication.—In the Commons the other day, in reply to Admiral Field, Mr. Bryce said that, in addition to the works recommended in the recent (third) report of the Royal Commission, there were still some works, recommended in the first report which had not yet been carried out. A sum of £11,000 had been placed at the disposal of the Board of Trade for the purpose of effecting electrical communication with light vessels, &c., during the present financial year, and the Board were at present considering on which of the works recommended that amount—which was not sufficient for all—should be expended.

It is stated that a telephone is to be erected between the Ramsgate Coast Guard Station and the watch-house on the pier, for lifeboat service.

Mauritius v. Madagascar.—In a recent issue, one of our contemporaries publishes a translation from a well-informed French paper concerning the Madagascar cable. From this source we gather that while negotiations on the subject of this contract were pending, the group of companies who work the telegraph lines between Marseilles and Mozambique offered to the French Government a reduction of about 25 per cent. on the tariff for private messages (as opposed to official messages, where the reduction offered was 50 per cent.). Now the present rate from England to Mozambique, where the cable from Madagascar joins the existing system, is 8s. 10d. per word. The companies were apparently willing to reduce this amount to (about) 6s. 8d., if the negotiations with the French Government had been successful. With these figures before us, it would appear that the telegraphing public of Mauritius have cause to examine carefully the position in which they are left. The cable which unites Mauritius with the general system at Zanzibar, was laid in 1893, under an annual Government subsidy of £28,000, payable for 20 years, of this sum the Colony of Mauritius contributes £7,000 yearly. The rate per word from England to Mauritius was originally 8s. 9d., at which figure it still remains, notwithstanding the fact that the rate to Zanzibar was lowered last month from 7s. 9d. to 5s., a decrease of 2s. 9d. per word. Now, in view of the recent reductions on the East Coast of Africa, and also of the favourable terms offered to the French Government for the Madagascar traffic, the English colony of Mauritius might reasonably have expected that the present high rate would have been lowered by at least 2s. 6d. per word. Here we may mention that the local rate between Zanzibar and Mauritius is 4s. per word, or just 1s. less than the rate per word between Zanzibar and London, and only 9d. per word less than between London and South Australia. That the Eastern and South African Company are well able to make such a concession is obvious, when we bear in mind that (according to the "Stock Exchange Year Book") in nine years, beginning with 1885, this company have paid in dividends to the shareholders the sum of £609,000 on a share capital of £600,000 (the *total* dividend paid on above capital since the registration in 1879 being, according to the above authority, £867,000). This statement does not include the amounts paid, and payable to, debenture holders representing over £1,000,000.

Telegraph Offices in Rural Districts.—In the House of Commons the other day, Sir John Hibbert said that much has been done of late years to encourage the extension of telegraphs in country districts. Rural sanitary authorities have been empowered to give guarantees for this purpose; the conditions of the guarantees have been very considerably lightened; and the Post Office is constantly making inquiries as to whether the business likely to be done at village post offices will justify the extension of the telegraph without any guarantee at all. The result has been that the number of country telegraph offices is increasing steadily and at a growing rate. In 1890-91 the increase was 275; in 1893-94 it was 673. Mr. A. Morley said: There are about 500 telegraph offices in the metropolitan district, or in other words, about one office to 10,000 people. Elsewhere there are about 9,150 offices, or one office to 3,600 people. The offices in the Metropolis have been established to meet the requirements of the public, and are only maintained if they pay their way. To close any of them would not facilitate the establishment of telegraph offices in rural districts. Both these replies were to questions put by Mr. Henniker Heaton.

The Pacific Cable.—A despatch from Ottawa, on Tuesday, said that Fanning Island has been definitively selected as the Pacific cable station, partly because the United States refuses to acquiesce in the acquisition by Great Britain of a Hawaiian island, and partly because the route will thus be entirely British.

The Telephone.—In *Cassier's Magazine* for May is an article by Mr. W. Clyde Jones, giving in a concise and interesting style the history of the telephone and its science, and detailing chronologically the various platforms in the evolutionary process which have brought the telephone to its present condition. The article comprises a summary of the experimental researches and discoveries of Oersted, Sturgeon, Henry, Faraday, Morse, Boursel, Reis, Bell, Elisha Gray, Berliner, Edison, Blake, and Hunnings, and the improvements which have been effected in telephonic systems as the outcome of their endeavours. Prof. D. E. Hughes has no place in the article. In the same magazine an article appears from the pen of Mr. Morgan Brooks, on the "Telephone and its Operation." By a number of photographic illustrations and diagrams, the author shows the various departments of a telephone exchange, sectional views of switchboards, and other apparatus, and describes in great detail the general working of an up-to-date telephone system.

The Telephone in France.—It is announced that Toulouse, Paris, Marseilles, and Bordeaux, are now connected by telephone. At the banquet given to commemorate the event, the toast in honour of the President of the Republic was telephoned direct to the Elysée by M. Ozenno, President of the Toulouse Chamber of Commerce.

The Telephone Service.—The *Financial Times* has, within the past few days, interviewed several City personages for the purpose of obtaining their views regarding the working of the telephone, and as to which body is in a position to carry the service on most efficiently. Among those interviewed were Mr. G. C. Lamb, of the Post Office; Mr. Emile Garcke, of the Chamber of Commerce; Mr. W. H. Dickinson, of the London County Council; Mr. Bates, of the City Commissioners of Sewers; and Mr. Gaine, of the National Telephone Company.

The number of replies received by the Commissioners of Sewers to their circular asking whether the provision now made for the telephone service was adequate, and whether it was expedient to supple-

ment or improve the provision, either by the granting of licenses to local authorities or otherwise, was 1,085, from which replies "it was quite clear that the existing telephone service was costly and inefficient."

Todmorden.—On behalf of the Todmorden District Council, direct telephonic communication has been set up between the Town Hall, the Fire Engine Station, the Market, the Gas Works for Millwood, Beggarington Workhouse, and the Fielden Hospital at Langfield. The communication covers a distance of over four miles. Mr. R. S. Blackburn, of Hebden Bridge, has executed the work. Mr. Blackburn has also recently completed an installation of telephones for Messrs. J. Smith, Limited, Cornholme. This is an intercommunication system. The G. E. C. Hunnings sets have been adopted. Metallic circuits have been run in wood casings, and over 1¼ miles of 18 s wire (insulated) has been used in the work.

CONTRACTS OPEN AND CLOSED.

OPEN.

Brighton.—May 27th. The Corporation invite tenders for lamp pillars, and brackets.

Brighton.—May 27th. The Corporation invite tenders for arc lamps, &c.

France.—May 25th. The Prefecture of Saint Lô, at Cherbourg (Manche), is inviting tenders for the operation of electric tramways in Cherbourg.

France.—May 30th. The French War Department, in Paris, is inviting tenders for the supply of the optical telegraphic apparatus required by the military telegraph service from 1895 to 1897, inclusive.

France.—The Municipal Authorities of La Teste de Buche (Gironde) are at present inviting tenders for the electric lighting of the town.

Godalming.—Proposals for lighting (private and public) the borough for the Town Council. Further details will be found in our advertisement supplement.

Hanley.—May 27th. The Corporation invite tenders for boilers, arc lamps and posts, cables, transformers, &c. Tenders to be sent to Mr. Lobley, the Borough Engineer, from whom particulars can be obtained.

Huddersfield.—June 1st. Tenders are invited for cables, transformers, switches, &c., for the Town Council's installation. Fuller details will be found among our advertisements.

Manchester.—May 31st. Tenders are invited for laying a system of underground telephone pipes, with brick inspection pits, service boxes, and other appurtenant works in certain streets. Details may be obtained, on application at the City Surveyor's Office, Town Hall, Manchester.

Roumania.—July 29th. The Municipal Authorities of Braila, Roumania, are inviting tenders for the concession for the construction and operation of an electric tramway along the main streets of the town.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Shoreditch.—May 31st. Tenders are invited for wiring and fitting the Town Hall for electric lighting. Further details will be found in our advertisements.

Tunbridge Wells.—May 28th. The Corporation are inviting tenders for the wiring of the municipal buildings, in accordance with the specification prepared by the electrical engineer. Full particulars to be obtained from the Town Clerk at the Town Hall.

CLOSED.

Birmingham.—The City Council have now accepted the tender of Messrs. B. Verity & Sons, of Birmingham, for the provision of electric plant for the new school, for the sum of £5,714 11s. 11d., in place of that of Messrs. D. & G. Graham, the trustee of whose business under sequestration had declined to fulfil the contract.

Coventry.—For the erection of a generating station for electricity, car-shed, boilers, and dynamos, for the Coventry and District Tramways, the tender of Mr. C. Haywood, jun., has been accepted.

Leeds.—The tender of Messrs. Babcock & Wilcox has been accepted for the supply and fitting up of boilers in the electrical department of the new post office.

Brighton.—The following tenders were sent in for supply and erection of boilers at the Corporation electricity works, and for supply of cables, for the Corporation:—

Supply and Erection of Boilers.

H. & T. Danks, Limited	£4,750
Yates & Thom	3,785
Hawksely, Wild & Co.	3,750
J. Thompson	3,660
Davy, Paxman & Co.	3,644
Penman & Co.	3,500
Fraser & Fraser, Limited	3,486
R. Hornsby & Sons, Limited	3,300
Babcock & Wilcox	3,100
Tinkers, Limited	3,060
J. Fraser & Son	2,938
Spur, Inman & Co., Limited...	2,870
Fleming & Ferguson	2,760
E. Danks, Oldbury	2,627
R. Taylor & Sons	2,165

Supply of Vulcanised Rubber and Lead-Covered and Armoured Cables, at per mile.

	A.	B.
India-Rubber, &c., Company	£396	£297
W. T. Henley's Telegraph Company	337	279
Telegraph Manufacturing Company	335	281
Fowler-Waring Cables Company	328	268
W. T. Glover & Co.	298	240
Callender's Bitumen, &c., Company	290	255
Siemens Brothers & Co.	289	239
British Insulated Wire Company	230	215

A. Three-core cable. B. Two-core cable.

For the boilers, the tender of Messrs. Babcock & Wilcox was accepted. The Corporation first accepted the tender of the British Insulated Wire Company for the cables, but as they afterwards wrote begging to be allowed to withdraw their offer because of a mistake which had occurred in it, the Corporation, agreeing to that course, accepted the tender of Messrs. Siemens, Brothers & Co.

Portsmouth.—The contract for one mile of earthenware pipes for conduits has been given to Messrs. Jennings at 2s. 11d. per yard. These are for the extensions.

BOOK RECEIVED.

Law of Copyright in Designs. By Lewis Edmunds, D.Sc., LL.B., assisted by Messrs. Stevens and Slade. Published by Sweet and Maxwell, Limited, 3, Chancery Lane, London.

NOTES.

The Determination of Dielectric Constants.—A new method of determining dielectric constants has been devised by W. Nernst, the essential features of which are as follows:—Two adjustable electrolytic resistances are placed, respectively, in the arms, A B, A C, of an ordinary Wheatstone bridge; in each of the other two arms, viz., B C, C D, is inserted a condenser consisting of two metal plates separated by a movable glass plate. The condensers are in every respect similar. The ends, A, D, are connected with an induction coil, whilst the ends, B, C, are put into communication with a telephone in which silence, or, at least, a minimum of sound, occurs when $R_{ab} : R_{ac} = C_{db} : C_{dc}$. A condenser, consisting of a nickel or platinum trough with a fixed metal plate in the interior, can be placed in either of the arms, D B, D C, and its capacity added to either of the measuring condensers; this trough contains the liquid whose dielectric constant is to be measured. Minimum sound is then obtained by moving the glass plate in the measuring condenser. The arms, D B, D C, also contain auxiliary resistances, so that if the compound examined is not a perfect insulator, its resistance can also be determined, since a minimum sound also results when $R_{ab} : R_{ac} = R_{db} = R_{dc}$. The condensers and other parts of the apparatus are calibrated once for all. The results appear to be very uniform, and experiments made on various substances compare very well with those of Landolt and Jahn. The method is described more fully in the *Zeitschrift für Physikalische Chemie*, xiv., p. 622, where the probable errors are discussed, and details of the precautions which should be taken are given.

Death from a Low Voltage Shock.—A writer in the New York *Electrical Engineer* asks for an explanation of an accident which recently occurred in some mines at Leavenworth, Kan., resulting in the death of a strong, well-built man, although the E.M.F. on the circuit from which deceased received the shock did not exceed 280 volts. The unfortunate man received the shock while attending to an electric mining machine; others had received similar shocks without any serious results. In reply to this inquiry there were several letters. Mr. Richard Lamb considers

The fact that 110 volts does not paralyse the nerves, and that therefore the contact can most always be withdrawn at once, is the reason why we have had so few, if any, records of death occasioned by that voltage. With 280 volts in contact with a bleeding sore upon the hand, a person would be killed almost instantly. Blood being a good conductor of electricity, the current would be at once transmitted to the heart. For this reason I require all my men operating my logging and electric canal boat towing cableways, to wear rubber gloves, to prevent possibility of contact with a sore, although I only use 220 volts. Mr. Nikola Tesla told the writer that 10 volts applied to a bleeding sore on the hand would put a man to sleep.

Mr. J. B. Hench gives the explanation

That this person was in contact with the terminals of the machine, and that in some way the circuit supplying the power was broken; or, if the machine is of the percussion type, he must have been in contact with the terminals when the current was interrupted and reversed, so that in either case he would have received the effect of a current due to induction and not the effect of a current due to 280 volts. The writer has in mind an instance where a gentleman, taking the voltage of a 100-volt machine, was thrown a considerable distance by some one opening the switch in the circuit supplying the power, thus accidentally receiving the full effect of the induced current.

A third writer (Mr. H. L. Tyler) attributes the cause of death to fright rather than shock. He holds that while one might, from a 280-volt circuit, receive quite a startler and become unconscious, direct electrical death would occur only when extraordinary preparation was made. However, these statements prove the necessity of exercising every precaution even in dealing with low voltage circuits.

The Burning of Tesla's Laboratory.—Now that a little time has elapsed since the disaster which overwhelmed Nikola Tesla's laboratory, it is possible to sum up the significance of the event. Our sympathies have been with this unfortunate physicist from the first, and for good reasons. But the average newspaper man, who, by the way, was mostly extravagant with his commiseration, would probably hesitate to venture upon an answer were he asked to explain definitely what he was grieving about. The thing was terribly overdone at the time it happened, and, in illustration of this, we believe it to be a fact that one vivid young lady of the trans-Atlantic press, in her anxiety to be instructive as well as "alive" in her descriptions, went so far as to depict herself undergoing a brilliant electrical ordeal, that is possible only with the body *in puris naturalibus!* For Tesla's future we have no fear. He is young and indomitable. It took Thomas Carlyle four weeks to quiet his mind after that miserable accident in which John Stuart Mill was concerned, which entailed the destruction of the first volume of the unprinted "French Revolution." But, in spite of sensational reports, we know it to be a fact that Tesla was at work again with clenched determination while the ashes of his hopes were still hot. No! The loss falls least heavily upon the loser. Like many another tireless experimenter, he hoped to give the scientific world the report of his failures as well as of his discoveries: he had not counted upon the casual destruction of his memorabilia and apparatus by fire. The loss falls most heavily upon those scientists who are at work upon the phenomena of high-frequency currents, of insulation, induction, impedance, and resonance, and the problems of obtaining cheap electricity by means of oscillators. In time, Tesla will doubtless reproduce all that was of value in those unfortunate notes and papers. In his own immediate work their loss will scarcely be felt, for his memory is all right, and flashes upon any experience of the past with the revealing power of a search light. But the years of toil which his work might have saved experimenters by indicating the paths which are open as well as those which are blind, are gone for ever.

Fire.—A fire which occurred at the Grange, Bromley Cross, Manchester, on 17th inst., is said to have been caused by fusion of electric wires.

Electrocution Vindicated.—Our New York contemporary, the *Electrical World*, has apparently abandoned the term *electrocution* in favour of electrical execution. It is difficult to say which is the more cacophonous; but on the whole we prefer the former. We are glad to be able to compliment our contemporary on the stand it is making against the cheap sensationalism which other American technical journals have permitted to invade their columns in respect to this subject. In a recent issue it published a report of a meeting of the New York Prison Association. At this meeting Dr. A. H. Goelet gave an account of his observations at the recent execution of a negro murderer at Sing Sing. In referring to the controversy recently excited by D'Arsonval's statement that the electric current as employed in the New York State Prisons does not inflict absolute death, Dr. Goelet ascribed it as partly due to the apparently negative results of the official examinations of the bodies of the first six criminals executed. Had the official pathologist, he said, who assisted at the post-mortems, not limited his examination of the brain to one case, he would have been able to have discovered what has now only three years later been demonstrated. A report prepared by Dr. T. E. Oertel on a microscopical examination of the blood and tissues of an executed criminal, was then submitted. From this we gather that (1) The chief action of the current is upon the blood and blood vessels; (2) The red corpuscles have less resistance than the white; (3) One or more of the elements determining coagulation of the blood is destroyed; (4) A germicidal agent is formed in the blood, which precludes the continued existence of multiplication of putrefactive organisms; (5) The liver is the organ most affected; (6) The lungs offer the most resistance; (7) The force exerted is sufficient to rupture the brain tissues and smaller vessels of the brain, and to produce universal hemorrhage in its substance; (8) The cellular elements of the tissues are not apparently destroyed; (9) The deviations from the normal conditions thus noted are sufficient to produce lethal results. In conclusion, Dr. Goelet states that death is instantaneous and painless, the latter being true because electricity travels faster than the nerves can transmit painful impulses. Hence we may confidently claim that if murder, as the law declares, must be expiated by the death penalty, electricity should be universally adopted as a method of accomplishing this in the most humane manner. But what will the *Lancet* say?

Marking Paper and Fabrics by Means of Electricity.—An application of electricity hails from Boston, U.S.A., which is designed for marking indelibly on paper, fabrics and similar materials. The *modus operandi* is very simple (and we may remark is by no means novel); it consists, in its essential features, as follows:—The material to be marked is moistened with water, or with some solution capable of conducting electricity, and laid on a metal plate connected with one pole of an electric battery or generator. The other pole is connected with a metallic stylus or stamp. On writing with this stylus, a current of electricity passes through the material, and an electrolytic action takes place, by which portions of the metal plate or of the stylus are dissolved and deposited on the material in the form of writing or design. If the deposit is not readily visible, it may be treated with some suitable reagent, in order to develop it, or the paper may be moistened with a suitable reagent, or the stylus dipped into it. In some cases, without solutions being used, some change is effected in the material, such that when it is moistened with water, the marking is rendered visible. This occurs when a platinum stylus or stamp is employed. In another modification of this process, which is due to C. Beadle, the paper or fabric may be marked by passing it in a moist condition between a pair of rollers, each of which is connected to one terminal of a battery.

The Lighting of Cheltenham.—The formal handing over of the works to the Cheltenham Corporation by the contractors took place yesterday week before a distinguished company. Mr. Preece, Mr. Siemens, Mr. Agg-Gardiner, the Borough member, Mr. Mordey, the Mayor and members of the Corporation, were among those present. In the evening the chairman (Mr. Alderman Norman) and the members of the Electric Lighting Committee entertained a small company to dinner at the Plough Hotel.

The Storage Battery in Telegraph Offices.—The largest storage battery installation in America for telegraphic purposes has recently, says the *Telegraph Age*, been made in the main office of the Western Union Telegraph Company at Atlanta, Georgia, where the 70 telegraph lines entering that office, in addition to all its local circuits, are now drawing current from an accumulator plant of 700 chloride cells, only one-half of which, however, are occupied at any one time in furnishing the electrical energy that previously required as many as 8,000 gravity cells. The battery equipment consists of 344 cells of 75 ampère-hour, 172 cells of 50 ampère-hour, and 172 cells of 25 ampère-hour capacity for the main lines, besides 12 cells of 250 ampère-hour capacity for the local circuits. The current for charging these cells is derived from two motor dynamos or direct current transformers of 7½ horse-power and 1 horse-power respectively, which are interposed between the electric power company's supply wires and the accumulator cells. The larger of these machines reduces the primary pressure of 500 volts to 110 volts for charging the main batteries, while the smaller machine reduces it to 16 volts for charging the local batteries. The main batteries, of which there are two sets that alternate daily between the charging and discharging circuits, are divided into eight groups of 43 cells, which are charged in the "multiple series" and discharged in the "simple series" arrangement. The distinguishing feature of the Atlanta installation consists of the transforming machinery, the necessity for which arises from the fact that no suitable supply of direct current can be secured in that city for the necessary purpose of charging the accumulators. In the case under consideration, for example, one of the motor dynamos converts the undesirable 500-volt power current of the Georgia Electric Light and Power Company into 110 volts—a pressure better adapted to the purpose of charging the main line batteries—while the other transformer accomplishes a similar purpose with regard to the charging of the local cells, which require but a comparatively low-pressure current, on account of the smaller number of cells involved. The Atlanta equipment includes an elaborate switchboard, upon which are placed switches, voltmeters, ammeters, fuses, &c.

Curious Electric Discharge.—Writing to the *Scientific American* recently, Mr. Gus. Schade, of Anaheim, Cal., said:—"I am making asphalte pipe. The process is as follows:—Crude asphaltum and gravel, equal parts by measure, are each heated in separate kettles to 400° F., then both are mixed together and filled into sheet iron moulds. The space between the moulds is maintained by a cast-iron ring on the bottom, and the moulds are held to that ring by inside and outside wrought-iron rings. After the moulds are cooled off, which takes time according to the size of the pipe, from two to eight hours, they spring off from the pipe after the wrought-iron rings have been removed and the moulds tapped with a hammer. Just at the moment the moulds spring off there can at times be seen large sparks between the sheet-iron and the pipe. By having my hands on the pipe and the moulds, I received sometimes such heavy shocks as to draw my arms together. Men working for me have experienced the same. The object of this letter is to find out if you, or any of your readers, can explain how this electricity, for such is what I judge it to be, accumulated there, and why it discharges just at the moment the moulds are taken off." Referring to the letter in a foot-note, our contemporary remarks that the description suggests that a condenser is formed by the combination, which is discharged on opening the mould, but whence the charge is derived is not clear. Surely it is merely an electrophorus effect!

A Chemometer.—To any instrument that would be capable of measuring the chemical intensity of any given system of substances, or that would show whether any two systems were in chemical equilibrium, the name "chemometer" may be given. The invention of this name, is due to W. Ostwald, who, in a recent paper discusses generally the conditions which such a philosophical instrument would have to fulfil, and points out that for electrolytes the electrometer may be considered as a chemometer, since chemical intensity and electromotive force are proportional to one another.

Electric Shock from a Secondary Alternating Current.—A writer in a recent issue of the New York *Electrical World* records several instances of men who received severe shocks while standing on damp earth engaged in turning on lamps supplied from secondary alternating circuits. In one of the instances quoted, the ground detector at the station showed a ground on the line, and upon examination two transformers were found to be burnt out. In another case a man was instantly killed as he reached to turn on the light above his head; an employé afterwards was trying to explain the accident to some one, and upon touching a snap switch, and the floor being damp, he was thrown some distance and badly burnt. An examination of the transformer showed a ground of one primary and one secondary wire on the case. In another case, on the same company's circuit, a servant girl stood in her slippers on a damp cement floor and was hurled to the ground senseless by shock received. An identical instance is recorded of a boiler engineer. The writer thinks of grounding the secondary wire to earth, though, as he has never heard of it before, he is nervous of the probable results. A correspondent writing to us on the subject, says:—"It seems to me that the cure for accidents of this kind lies in the use of earthing devices of the Cardew or other types, which will put the secondary circuit to earth automatically, should the secondary E.M.F. from any reason rise above the normal to any great extent. In Scarborough we have one of these earthing devices connected to every transformer, and I think it is a wise precaution to adopt."

City and Guilds of London Institute.—The fifteenth annual report to the governors of this Institute, which has recently been issued, states that the total income of the Institute amounted to £33,974 17s. 4d., £10,207 4s. 7d. of which was made up of school fees. The total expenditure amounted to £30,429 18s., leaving a balance of £3,544 16s. 7d. At the Central Technical College the total number of students who attended during the year was 222, an increase of 17 over last year. At the Finsbury Technical College the total number of students was 197, as compared with 213 in the previous session. This decrease was due to the smaller number of second year students in the mechanical and electrical departments, a larger proportion than usual of first year students of the previous session having failed to obtain promotion to the second year course. The equipment of the electrical laboratory has been increased by the purchase of the polyphase apparatus used for the transmission of power at the Frankfort Electrical Exhibition. In the Evening Department of the College 1,091 tickets were sold to 922 individual students, as against 1,183 sold in the preceding session to 980 students. The decrease is thought to be due partly to the influence of the Polytechnic Institutions in and around London, for it has shown itself mostly in the classes in plumbing, machine design, and electric technology. There has been no decrease in the total number of students taking tickets for complete courses, and the attendance in the Art Department has increased from 158 to 207, the highest since the opening of the College. As regards technological examinations, there has been an increase of 1,344 in the number of students attending classes in the previous session, the total number being 25,718, and the number of classes registered showed an increase of 19. 11,631 candidates had presented themselves for examination, an increase of 1,377 over last year. The percentage of failures had fallen from 46·4 to 44·6. For the preliminary examination in electric lighting 287 candidates presented themselves, of whom 216 passed. The total number of candidates for electric lighting was 689, against 439 for last year.

The Formation of Ozone by the Action of Electric Oscillations.—A piece of research recently carried out jointly by E. Wiedemann and G. C. Schmidt, will be regarded as of considerable importance by those who are interested in the commercial production of ozone. In a paper published in the *Annalen der Physik und Chemie*, xiii., p. 924, they demonstrate that if, in the preparation of this gas by the influence of the silent discharge, means are adopted to obtain oscillations of a regular periodic nature, the yield of ozone is largely increased. It is noticeable that these scientists only worked at low pressures when, as is well known, the yield of ozone is small, even under the most favourable conditions.

British Association for the Advancement of Science.—The sixty-fifth annual meeting of this Association will commence at Ipswich on Wednesday, September 11th, 1895, the president for the year being Captain Sir Douglas Galton, K.C.B., D.C.L., &c. The local secretaries will be G. H. Hewetson, Esq., S. A. Notcutt, Esq., B.A., LL.M., B.Sc., E. P. Ridley, Esq., and the local treasurers H. J. W. Jervis, Esq., Roger Kerrison, Esq. The President's Address and the evening discourses will be delivered in the Public Hall. General committee—The general committee consists of the following classes of members: Class A, permanent members. 1. Members of the Council, presidents of the Association, and presidents of the sections for the present and preceding years, with authors of reports in the *Transactions* of the Association. 2. Members who, by the publication of works or papers, have furthered the advancement of those subjects which are taken into consideration at the sectional meetings of the Association. With a view of submitting new claims under this rule to the decision of the Council, they must be sent to the assistant general secretary at least one month before the meeting of the Association. The decision of the Council on the claims of any member of the Association to be placed on the list of the general committee is final. The first general meeting will be held on Wednesday, September 11th, at 8 p.m. precisely, when the Most Hon. the Marquis of Salisbury, K.G., D.C.L., F.R.S., chancellor of the University of Oxford, will resign the chair, and Sir Douglas Galton, K.C.B., D.C.L., F.R.S., president elect, will assume the presidency, and deliver an address; on Thursday evening, September 12th, at 8.30 p.m., a soirée; on Friday evening, September 13th, at 8.30 p.m., a discourse will be delivered by Prof. Silvanus P. Thompson, F.R.S., on "Magnetism in Rotation;" on Monday evening, September 16th, at 8.30 p.m., a discourse by Prof. Percy F. Frankland, F.R.S., on the "Work of Pasteur and its Various Developments;" on Tuesday evening, September 17th, at 8.30 p.m., a soirée; on Wednesday, September 18th, the concluding general meeting will be held at 2.30 p.m. Excursions to places of interest in the neighbourhood of Ipswich will be made on the afternoon of Saturday, September 14th, and on Thursday, September 19th.

News from Cornell.—Our readers have frequently had brought before them the results of the joint labours of Messrs. Bedell and Crehore. Dr. Bedell, who belongs to the Physical Department of Cornell University, is now collaborating with Miss Mary L. Crehore, of Cleveland, the news of his engagement having just reached us. We congratulate him, and trust that his treatment of the lady of his choice will be, like that of his book on "Alternating Currents," based upon simple elementary ideas, and complete in itself, so that no previous knowledge of the theory of electricity and magnetism is necessary (on her part). But as the solution for each particular case is derived independently from the differential equations and also from the general integral equation, we have no doubt that by graphical treatment alone Dr. Bedell will have no trouble in solving the new problem he has undertaken. We say graphical treatment advisedly, for the results obtained by analytical processes too often fail to carry their full significance while in symbolic form.

The Electropoise.—The Electropoise, notwithstanding what has been said of it in our own columns, and more particularly in *Science Siftings*, seems to flourish, judging by a full page advertisement of this appliance, "which polarises the entire body," appearing in the *Gentleman's Journal* for May 15th. In America our contemporary, *Electricity*, has been waging a war of extermination against this "home cure without medicine" with, we believe, considerable success, and we thought its pretensions had been completely exposed in the old country. However, it was evidently only scotched, not killed, so we would suggest that the poor foolish dupes whose testimonials are printed in the aforesaid advertisement should read *Science Siftings* to learn what the Electropoise consists of.

The Northern Society of Electrical Engineers.—The Council of this Society regret that Mr. John Darney has been compelled to resign his position as hon. secretary, owing to his removal from Manchester. Mr. J. Vincent Swindells is acting in his stead.

Benevolence!—We learn from a contemporary that "Mr. F. L. Rawson, who has taken offices at 33, Cornhill, has purchased the goodwill and all the patent rights of Woodhouse and Rawson United, Limited, from the Receiver, together with the works at Manchester, and we hear that it is his intention to work it not for his own profit, but in some way which will benefit the shareholders of the late company. The official sanction was given to the first part of this agreement last Friday at the Law Courts, but, unfortunately, nothing transpired as to how the second part was to be worked."

Personal.—Mr. J. R. Cowell, formerly of the firm of Phillips & Cowell, consulting engineers, Southampton, has been appointed general manager of the Town Lighting Department of Johannesburg. It was decided some time ago by the authorities to light the town by electricity, and this will be superintended by Mr. Cowell.

The Therapeutic Value of High Frequency Currents.—On page 636, there is an interesting paper by MM. Apostoli and Berlioz on the therapeutic value of high frequency alternating currents, which is well worth considering by those who are endeavouring to utilise electricity in combating the ills to which flesh is heir. It is to be hoped that these experiments will not be suffered to lapse, but will be continued, so that further data may be accumulated.

The Institution of Civil Engineers.—At the last ordinary meeting of the session, held on Tuesday, May 21st, Mr. W. H. Preece, C.B., F.R.S. (Vice-President), in the chair, it was announced that seven associate members had been transferred to the class of members, and 27 candidates had been admitted as students. The last ballot of the session resulted in the election of two honorary members, four members, and of 38 associate members. On Tuesday, May 28th, at 8 p.m. (in the Theatre of the Royal United Service Institution, Whitehall, by the kind permission of the Council), will be held the annual general meeting of corporate members only, to receive the report of the Council, and to elect the council and auditors for the ensuing year.

Mr. Henry Wilde's Generosity.—The Governors of the Manchester Grammar School have accepted with gratitude the present of Mr. Henry Wilde, F.R.S., of two dynamo machines and some other electrical and magnetic apparatus, and also Mr. W. J. Crossley's present of a gas engine for driving the dynamos.

Royal Institution.—The Friday evening discourse on May 31st will be delivered by the Earl of Rosse, K.P., F.R.S., the subject being "The Radiant Heat from the Moon during the Progress of an Eclipse." That on June 7th will be by Prof. Alfred Cornu, F.R.S. This discourse will be delivered in French, and the title will be "Phénomènes Physiques des Hautes Régions de l'Atmosphere."

The Colour of Solutions.—This subject just now is exercising a singular fascination for physical chemists who believe that presently they will be able to put forward some important generalisations. Some have attempted to explain the phenomenon of colour in salt solutions by means of the dissociation theory alone; but it has recently been pointed out by J. H. Kastle that this theory by itself appears to be incompetent of affording a sufficient explanation. The hydrate theory of solution, which is affected by one school of scientists, also seems incapable of satisfactorily explaining the facts which have been observed. Kastle has accordingly advanced a new hypothesis, namely, that the colour of a salt solution is dependent, not on the colour of the ion, but on the colour of the base, or that of the acid, either, or both of which may be coloured. The argument with which he supports these views (*vide American Chemical Journal*, xvi., p. 326) is largely one of analogy, and presents many points which appear to us open to attack. Doubtless the upholders of the dissociation theory will not be slow to avail themselves of these weaknesses.

Lectures.—In connection with the thirteenth annual meeting of the London Chamber of Commerce, Mr. W. H. Preece, C.B., F.R.S., yesterday afternoon delivered a lecture at the Hall of the Carpenter's Hall, London Wall, E.C., on "Telegraphy by Induction."

At the monthly meeting of the Aberdeen Branch of the Educational Institute of Scotland, in Gordon's College, on 18th inst., Prof. Andrew Jamieson delivered a lecture on "Technical Education in Scotland."

Some Points in the Extraction of Gold.—G. A. Goyder has been investigating the action of potassium cyanide on gold and on some other metals and minerals. His experiments were made to approximate, as closely as possible, to the conditions that attain in the commercial process of extraction by means of cyanide. Besides other results of less particular interest to our readers we notice the following:—That the presence of oxygen is required to effect the solution of gold, &c., in solutions of potassium cyanide; and, that under the influence of an electric current, such solutions deposit their metallic contents, whilst the potassium cyanide gradually undergoes decomposition into potassium and ammonium carbonates; and that if the current is interrupted, the gold redissolves as long as sufficient potassium cyanide remains in solution. This reminds us that a new method of extracting gold from auriferous ores has recently been proposed by C. Lossen (*Berichte der Deutschen Chemischen Gesellschaft*, xxvii., p. 2,726). He electrolyses a solution of potassium bromide, and obtains an alkaline solution which contains hypobromite and bromate, and which is capable of dissolving gold. The ore is treated with excess of this solution in rotating cylinders, the solution is then filtered, the gold is precipitated by passage over a mixture of iron and coal, and the solution, which now contains mainly potassium bromide, is electrolysed, and again used for extraction.

Meeting of the Société Internationale des Electriciens.—The meeting of the Société Internationale des Electriciens took place on May 1st, 1895, with M. R. Picou in the chair in the place of M. Potier. M. Rey first gave a description of M. Blondel's *lumen-meters*, an invention which allows of the direct determination of the mean spherical intensity of sources of light. This apparatus consists of a sphere of metal carefully blackened, in the centre of which is placed the luminous source to be studied. This sphere has one or more openings in the form of spherical spindles, with a vertical ridge. The stream of light passing through is concentrated by a projector on to a diffusing screen, which throws it back on to a photometer. M. A. Bochet then described the electrical installations of the metropolitan extension of the Sceaux line. The lighting is effected by 96 arc lamps and 500 incandescence lamps. The electrical energy is also used for working a swing-bridge, five lifts, two turntables, a pump and a ventilator. These various apparatus are distributed over the Place Denfert, Port Royal and Luxembourg stations. The extension of the Sceaux railway is underground, and has to be lighted all day. The swing-bridge, lifts, turn-tables and ventilator work intermittently. In order to avoid excessive consumption at certain moments, accumulators are used, which furnish the various amounts of energy required. The installation was carried out by the firm of Sautter, Harlé & Co. It is established at the Denfert station, and the mains extend as far as the Luxembourg station, a distance of 3·2 kilometres. The distribution is on the three-wire system, and at 250 volts on each bridge. The central station contains two Roser boilers, two horizontal steam engines, supplied by Chaligny & Co., of 120 H.P., at 85 revolutions per minute, two dynamos with two armatures at 420 revolutions per minute. Each armature gives normally 270 volts and 160 amperes. Without going too much into details, we may say that the ventilator at the Luxembourg station, which is intended to draw air into the underground part of the railway, and to drive it out, can give out 180,000 cubic metres per hour. M. Ch. Street then read a paper on electric stoves, and their application to the transformation of carbon into graphite by the Girard and Street process. After a very complete explanation, M. Street described several models of stoves, and mentioned some recent applications.

NEW COMPANIES REGISTERED.

Cambridge Scientific Instrument Company, Limited (44,083).—This company was registered on May 11th, with a capital of £10,000 in £5 shares, to acquire the business carried on at Cambridge by H. Darwin as "The Cambridge Scientific Instrument Company," to adopt a certain agreement, and to carry on the business of mechanical and electrical engineers and scientific instrument and apparatus manufacturers. The subscribers (with one share each) are:—L. Darwin, 18, Wetherby Place, S.W., major; F. Darwin, Fellow of Christ's College, Cambridge; E. H. Darwin, 12, Parkside Cambridge, tutor; W. N. Shaw, M.A., Emmanuel College, Cambridge; H. F. Newall, Madingley Rise, Cambridge; G. H. Darwin, Newnham Grange, Cambridge, professor; H. Darwin, St. Tibbs Row, Cambridge, manufacturer. The number of directors is not to be less than three nor more than six; the first are H. Darwin, L. Darwin, H. F. Newall, and W. N. Shaw; qualification, one share; remuneration as fixed by the company. Registered by H. and G. Keith, Union Bank Buildings, Ely Place, Holborn.

D.P. Battery Company, Limited (44,084).—This company was registered on May 11th, with a capital of £10,000, in £1 shares, to adopt certain agreements, and to make, buy, sell and repa and deal in accumulators or secondary storage batteries and accessories for electrical purposes. The subscribers (with one share each are:—W. C. Johnson, Westcombe Park, Blackheath, civil engineer; Mrs. W. C. Johnson, Westcombe Park, Blackheath; B. Drake, 66, Victoria Street, S.W., electrical engineer; J. M. Gorham, 66, Victoria Street, S.W., electrical engineer; A. C. Read, 66, Victoria Street, S.W., accountant; E. G. Giller, 174, Maxey Road, Plumstead, clerk; Mrs. B. Drake, The Gables, Mitcham, S.W. The number of directors is not to be less than two, nor more than four. Qualification 500 shares; remuneration as fixed by the company. Registered by Geo. Whale, 54, Cannon Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

New British Electric Installation Contractors, Limited (37,439).—The registered office of this company was removed by notice dated April 11th, from 21, Broad Street, Worcester, to The Avenue, The Cross, Worcester.

Newport Electrical Engineering Company, Limited (42,292).—The registered office of this company is situate at 68, Dock Street, Newport, Monmouth, notice of which was filed on April 17th.

Merveilleuse Electric Arc Lamp Syndicate, Limited (38,699).—The annual return of this company was filed on April 9th. The capital is £15,000, in £1 shares, of which 10,107 have been taken up. 9,000 of these have been issued as fully paid, and the full amount called on 1,107 shares. £725 has been received, and £382 is in arrears.

Mazarron Electric Light Company, Limited (38,277).—The annual return of this company was filed on March 21st. The capital is £15,000, in 10,000 ordinary shares of £1 each and 500 preference shares of £10 each. All the ordinary and 131 preference have been taken up, and 9,993 ordinary have been issued as fully paid. The full amount has been called and paid on the remainder.

Railway Electrical Fog Signal Syndicate, Limited (35,174).—The annual return of this company, for 1894, was filed on April 27th, when 18,000 shares were taken up, and issued as fully paid, out of a capital of £25,000 in £1 shares.

Oxford Electric Company, Limited (34,685).—The annual return of this company was filed on April 23rd. The capital is £100,000 in £5 shares. 6,586 shares have been taken up, and the full amount called and paid.

Randall's Phonautograph Company, Limited (42,412).—The statutory return of this company was filed on March 27th. Thirty-two shares have been taken up out of a capital of £25,000 in £1 shares; 26 shares have been taken up, and had the full amount called and paid; six shares have also been taken up, but nothing has been called.

Ransomes, Sims & Jefferies, Limited (19,802).—The annual return of this company was filed on April 26th, when 3,087 shares were taken up out of a capital of £500,000 in £100 shares. The full amount has been called on 2,361, and £50 per share on 726, and the calls paid amount to £272,400.

Phosphor Bronze Company, Limited (8,383).—The annual return of this company was filed on April 22nd. The capital is £150,000, in £5 shares (15,000 preference and 15,000 ordinary); 8,373 preference and 7,335 ordinary have been taken up, and the full amount called and paid.

Orme's Electric Signal Syndicate, Limited (39,057).—The annual return of this company has just been filed. The capital is £7,500, in £1 shares; 6,350 shares have been taken up, of which 6,000 have been issued as fully paid. The full amount has been called and paid on the rest.

Rainbow Engineering Company, Limited (38,762).—The annual return of this company was filed on April 6th. The capital is £20,000, in £5 shares, of which 1,831 have been taken up; 1,500 have been issued as fully paid, and the full amount has been called on 331 shares; £1,162 4s. has been received, leaving £492 16s. still unpaid.

Printing Telegraph and Construction Company of the Agence Havas, Limited (38,427).—The annual return of this company was filed on March 28th; 20,030 shares have been taken up out of the capital of £115,000, in £5 shares, of which 10,823 have been issued as fully paid; £3 per share has been called on the remainder, resulting in the payment of £9,554, with £18,067 in arrears.

Waterhouse Electro-Metric Syndicate, Limited (39,442).—The annual return of this company has just been filed. The capital is £20,000 in £10 shares. 1,308 shares have been taken up, of which 1,000 have been issued as fully paid to the vendors. The full amount has been called and paid in respect of the remainder.

Altrincham Electric Supply, Limited (40,795).—The statutory return of this company was filed on May 3rd (although made up to August 2nd, 1894). The capital is £50,000 in £1 shares, and 25,000 are taken up. Five shillings per share was then called and paid. The annual return was filed on April 18th; the same number of shares were then taken up, and 10s. per share called and paid.

Rose & Bird, Limited (42,753).—The statutory return of this company was filed on May 7th, when 2,184 shares were taken up out of a capital of £3,000 in £1 shares; 1,000 of these have been issued as fully paid, and the full amount has been paid on 1,184 shares.

Roger's Arc Lamp Company, Limited (42,767).—The statutory return of this company was filed on April 25th. The capital is £20,000 in £5 shares; 3,007 shares have been taken up, of which 3,000 have been considered as paid, and nothing has been called on the seven shares.

W. T. Henley's Telegraph Works Company, Limited (13,795).—The annual return of this company was filed on April 19th. The capital of £100,000, in £10 shares (7,000 ordinary and 3,000 preference), have been taken up, the full amount has been called, and the whole, with the exception of £60, received.

Anglo-Portuguese Telephone Company, Limited (24,545).—The annual return of this company was filed on April 17th. 50,000 shares have been taken up and issued as fully paid out of a capital of £75,000, in £1 shares. Share warrants for 4,020 shares are outstanding.

Ward Electrical Car Company, Limited (27,503).—The annual return for 1894 was filed on April 25th. The capital of £300,000, in £10 shares, has been taken up, and 29,993 of these have been issued as fully paid. The full amount has been paid on the remaining seven shares.

Woolwich District Electric Light Company, Limited (31,814).—The annual return of this company was filed on April 4th. The capital is £10,000, in £1 shares. 8,953 shares have been taken up, and 668 of these have been issued as paid, while the whole amount has been called and paid on 8,285 shares.

Woodfield Syndicate, Limited (34,037).—The annual return of this company was filed on April 10th, when the capital of £12,000 in £1 shares, being all taken up, was paid for in full.

A. Ransome & Co., Limited (37,861).—The annual return of this company was filed on April 24th, when the capital of £59,000 in £10 shares was fully taken up. 5,593 shares were issued as fully paid, and the whole amount was paid on the remaining 307.

Waterhouse Electrical Manufacturing Company, Limited (37,936).—The annual return of this company, for 1894, was filed on May 6th. The capital is £20,000 in £10 shares (1,000 vendors', 800 ordinary and 200 preference). All the vendors', 285 ordinary and 53 preference shares have been taken up, and the vendors' shares have been issued as fully paid. The full amount has been called on the rest, resulting in the payment of £3,330, leaving £50 unpaid.

CITY NOTES.

West India and Panama Telegraph Company.

The thirty-sixth ordinary general meeting of this company was held at Winchester House on Wednesday, Mr. C. W. Earle presiding.

The Chairman regretted that the present was the most unsatisfactory report they had had to submit since 1882. The only consolation was that the causes which led to this unfortunate condition of things were entirely beyond their control—chiefly the decline of business in the West Indies, the low value of sugar, which seemed to be the index of their business, and the increased skill of the merchant in the use of codes. When the line first started in 1869, their minimum was a 20-word message; but in deference to the growing custom among telegraph companies, the company made a rate some 12 or 15 years ago, with the result that at the present day, instead of 20 words per message, the average was 7·25. The decrease in traffic receipts for the six months—£1,949—was entirely due to falling off in business, as there had been no interruption in traffic at any station, and this, together with the increase of £952 in expenses—for repair of cable—made some £2,000 to the bad; otherwise they would have been able to pay the small dividend of 6d. per share. As it was, after paying interest on preference shares, there was only a balance of £710 to carry forward out of total receipts, including the amount brought forward of £12,480. With regard to the current half-year, there was no improvement in the receipts, but the expenses for repairs of cable would apparently be light. At the same time, they would lose the £2,000 hitherto paid them by the Government of Guadaloupe, so that their prospects were by no means bright. In spite of all this, however, meetings were being held in several of the West India colonies with a view of inducing the various governors to endeavour to put pressure upon the Home Government to subsidise a single line running through the middle of this company's system, with the view of bringing the rate down to 3s. per word. What probability there was of the Government attempting to saddle the English taxpayer with the cost of helping the West India merchant to carry on his business, he could not say; but they must be prepared for all things, and when it was remembered that they had duplicated their own cable under pressure from the various colonies, he failed to see how the desire for a single line came in.

The motion was seconded by Mr. W. Andrews, and carried.

Reuter's Telegram Company.

The directors report that after deducting the sum standing to the debit of profit and loss account from the previous year, there remained from the year 1894 a credit balance of £1,718, which is carried forward. The results would have been much more satisfactory but for the heavy expenditure entailed on the company by the war between Japan and China. Although the directors are unable to declare a dividend, they remark that shareholders will see from the figures for last year that the business of the company is sound.

The Western and Brazilian Telegraph Company, Limited.

Mr. W. S. Andrews presided at the general meeting of this company, held at Winchester House yesterday. After referring to the increase in the earnings of the company of £2,476, the chairman mentioned that there was a small increase in the international words exchanged; that is, exchanged between Brazil and foreign countries. There was a small decrease in the words exchanged in the territory of Brazil, but, all the same, there was a slight augmentation in the income from them, because the messages were, on the average, carried longer distances. After referring to the slight increase of £811 in the expenses and the charges on shipping, which had been abnormal, the chairman went through the items of the accounts in detail. The method of dealing with the income was then touched upon (see company's report in our last issue). They had lost £31,374 over exchange, and, considering this, their position was eminently satisfactory. The whole of the questions between the Brazilian Company had been settled in favour of the Western Company. The position with regard to the Brazilian Government was, that the Legislature had passed an Act authorising the purchase of the company's business. Negotiations and arbitration would begin in good time in Brazil, and they must wait patiently the result of such inquiry.

The report was then adopted.

Stock Exchange Notices.—The Stock Exchange Committee has ordered the undermentioned securities to be quoted in the Official List:—Edison and Swan United Electric Light Company, Limited—89,261 "A" shares, Nos. 1 to 89,261, and £100,000 4½ per cent. debenture stock, in lieu of the shares of the Swan United Electric Light Company, Limited, now quoted. W. T. Henley's Telegraph Works Company, Limited—3,000 7 per cent. preference shares, Nos. 1 to 3,000; and £50,000 4½ per cent. mortgage debenture stock.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 19th, 1895, amounted to £905; week ending May 20th, 1894, £907; decrease, £2; total receipts for half-year, 1895, £18,720; corresponding period, 1894, £18,213; increase, £507.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending May 19th, 1895, amounted to £1,141; corresponding week last year, £1,282 (Whit week, 1894.)

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 17th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,584.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation May 15th.	Closing Quotation, May 22nd.	Business done during week ended May 22nd, 1895. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	47 — 49	46 — 48	47⅛	46⅛
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	85 — 86	84½ — 85½	85⅝	84⅛
2,993,560£	Do. do. Defd.	Stock	...	...	...	8¼ — 9	8¼ — 8⅜	8⅞	8⅜
130,000	Brazilian Submarine Teleg., Ltd.	10	6½ % §	6½ % §	...	12½ — 13	12½ — 13	13	12⅝
75,000£	Do. do. 5 %, repayable June 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	10% ‖ §	... §	...	3 — 4	3 — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	150 —154	154 —158	...	...
224,850	Consolidated Telep. Const. and Main., Ltd. ...	10/-	2 % §	2 % §	1½ %	1/16 — 1/8	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9⅜ — 10½	9⅜ — 10½	...	...
30,000£	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	4½ %	105 —108%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½ % §	2⅝ % §	2 %	9¼ — 9⅜	9¼ — 9⅜	9½	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½ % §	6½ % §	...	16½ — 16⅝	16½ — 16⅝	16⅝	16½
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	17¼ — 17⅜	17¼ — 17⅜	17½	17⅜
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	106 —109	...	...
1,297,837£	Do. 4 % Mort. Deb.	Stock	4 %	4 %	.	123 —126 xd	123 —126	123	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	16⅞ — 17⅛	16⅞ — 17⅛	17⅛	16⅞
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	104 —108	104 —108	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	105 —108	105 —108	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	124 —127	124 —127	125⅝	...
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	104 —108	104 —108	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	5 %	5 %	5 %	105 —108	105 —108	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	4 %	4 %	4 %	107 —110	107 —110	109¼	107⅓
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114%	111 —114%	112½	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞ % §	4⅝ % §	...	10 — 10½	10 — 10½	10 3/16	10
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	...	16⅞ — 17⅛	16⅞ — 17⅛	17⅛	16¾
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝ % §	8⅝ % §	8⅝ % §	21¾ — 22¼	21¾ — 22¼	21⅝	...
190,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	47 — 49	44 — 47	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½ %	1½ %	5 — 7 xd	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	6 %	6 %	6 %	105 —110	106 —110	106½	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	... — ...	... — ...	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	*nil*	4 %	...	1½ — 2½	1½ — 2½	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	5 % §	5 % §	5 %	5½ — 5⅝	5⅝ — 5⅝	5⅝	5⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15½ — 16½	15½ — 16½	15 15/16	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	14½ — 15½	14½ — 15½	15⅝	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	5 %	5 %	...	5⅞ — 6⅛	5⅞ — 6⅛	5⅛	...
1,100,000£	Do. 3½ % Deb. Stock Red.	...	3½ %	3½ %	...	104 —106	104 —106	105½	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... — ...	... — ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4½ %	9/16 — 11/16 xd	9/16 — 11/16	...	...
100,000£	Pacific and European Tel., Ltd 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	106 —109	106 —109	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	...	3½ — 4½	3½ — 4½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	123 —128	123 —128	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	85 — 90	85 — 90	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	0 %	...	4 — 5	4⅛ — 5½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	102 —105	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½ — 2½	1½ — 2½	1⅝	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	99 —104	99 —104	...	...
64,245	Western and Brazilian Teleg., Ltd.	15	2½ %	2½ %	3 %	10 — 10½	10½ — 11	10⅜	10¼
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ — 7	6½ — 7	6 1/16	6 1/16
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4 — 4½	4¼ — 4⅜	4½	4⅛
171,900£	Do. do. do. 6 % Debs. "A," 1910 ...	100	6 %	6 %	6 %	102 —106	103 —107	106	...
214,800£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	6 %	6 %	6 %	102 —106	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛ %	7/8 %	¼ %	7/8 — 1⅛	3/4 — 1	1 1/16	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	6 %	6 %	6 %	11 — 11½	10¾ — 11¼	11	10⅜
4,669	Do. do. do. 6 % 2nd Pref. ...	10	6 %	6 %	6 %	9 — 10	9 — 10	9⅜	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	5 %	5 %	5 %	110 —113	110 —113	112	110½
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	113 —118	113 —118	...	...
166,900£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	101 —103	101 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½ %	4½ %	5½ — 5⅝	5½ — 5⅝	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	14½ — 15½	14 — 15	14⅜	14 1/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½ — 15⅝	15½ — 16	15⅞	15⅝
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —136	133 —136	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½ %	7⅜ — 7½	7⅜ — 7⅜	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	2 %	2½ %	...	10¼ — 10⅜	10½ — 11	10 15/16	10⅜
100,000£	Do. 5% Deb., bonds of £10, £20, £40	...	5 %	5 %	...	... — ...	... — ...	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½ %	4½ %	...	118 —120	118 —120	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	7½ — 8	7½ — 8	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	7½ %	4½ %	6½ %	8¼ — 8⅜	8¼ — 8⅜	8 5/16	8¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8⅜ — 9¼	8¼ — 9¼	9⅛	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½ %	4 %	5 %	7⅜ — 8¼	7¼ — 8¼	8 3/16	7⅞

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, May 15th.	Closing Quotation, May 22nd.	Business done during week ended May 22nd, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §	6 % §	...	2⅝ — 2⅝	2⅝ — 2⅝	2¼	2⅛
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2½ — 2½	2½ — 2½	2½	2 7/16
125,000£	Do. do. 4½ % Deb.	Stock	4½%	4½%	...	113 —116	113 —116	...	...
630,000£	City and South London Railway	Stock	5%	5%	1½%	45 — 47	45 — 47	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	2½ — 3	2½ — 3	...	...
50,000£	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	5 %	5 %	5 %	... — ...	no quotation	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	*nil*	*nil*	...	⅛ — ¼	⅛ — ¼	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1½ — 2	1½ — 2	1¾	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	...	... — ...	... — ...	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	¾ — 1¼	1 — 1¼	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1⅛ — 1⅜	1⅛ — 1⅜	1 3/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	½ — 1½	½ — 1½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — ...	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	9½ — 1	10 — 11	10¼	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	21½ — 22½	21½ — 22½	22	21⅝
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	101 —103	101 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	9 — 9½	9½ — 9⅝	...	...
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	14 — 14½	14⅝ — 15½	...	...
	Swan United Electric Light, Ltd.	...	10 % §	7½% §	...	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	41 — 43	41 — 43	41	40½
150,000£	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	106 —109	106 —109	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2¼ — 2½	2¼ — 2½	2¼	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.
Electric Construction Corporation, 6 % Debentures, 84—87.
Electric and General Investment, shares of £5 (£1 paid), 1¼—2
House-to-House Company (£5 paid), 3⅞—4⅛.
Do. do. 7 % Preference, of £5, 7 —7½.
Do. do. 6 % Debentures of £100, 107—109.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7¼—7⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 7¼—7½.
London Electric Supply Corporation, £5 Ordinary, ¼—½.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 99—101 nominal.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5¼—6.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

ON THE RECENT DEVELOPMENT OF THE SINGLE-ACTING HIGH-SPEED ENGINE FOR CENTRAL STATION WORK. By MARK ROBINSON, Member. (Abstract of a paper read May 9th, 1895.)

(*Concluded from page* 628.)

Simple as it sounds, the "transfer" adds several parts to the engine. The cylinders are lifted a good deal, as a "transfer chamber" is required below the low pressure cylinder; the trunks or hollow piston rods are lengthened; and an extra valve and an extra gland are required in each line, and, of course, involve extra friction. Thus it is only under particular conditions of pressure, &c., that it is worth while to use the "transfer;" it is often better to add another complete stage of expansion rather than the transfer. It is, nevertheless, useful in cases where, for some extraneous reason, such as very great fluctuation of load, it is convenient to cut down the number of stages of expansion, as in an engine for electrical railway work. In such an engine the average load is usually but a small proportion of the extreme load, and the total cylinder volume should be so chosen as to give the best ratio of expansion, and therefore the most economical consumption, at the average load. It might then be impossible, without much complication, to obtain the extreme load at all, if the first cylinder were relatively so small as that of a triple expansion engine must be, and if the cut-off in it, for normal load, were as late as in a triple expansion engine it ought to be; it is better, therefore, to use a compound engine, gaining the needful expansion by cutting off early for average loads, and, of course, cutting off late (economically, too late), for extreme loads. Economy suffers from this, but it can be partly restored by adding another temperature division stage in the shape of the "transfer." Where the steam pressure exceeds 160 lbs., it is also worth while to add the "transfer" to a triple expansion engine; it takes it half way towards quadruple expansion, the latter not being, in a Willans engine, worth the complication it introduces, until the pressure is well over 200 lbs.

Brake Efficiency.—After some months' running, it is not uncommon to find the brake efficiency of compound engines as high as 92 per cent., but on trial at the works, when the rings are new and not yet brought up to a good face, it is rare to get more than 90 per cent., and 89 per cent. would not be thought unsatisfactory. In a triple-expansion engine 87 or 88 per cent. is a good result when new. Though experiments are sadly wanting, it is believed that these figures are much about the same as those for good double-acting engines, in which there is less ring friction but more bearing friction.

The possible higher efficiency of double-acting engines at light loads is well illustrated in a paper read by Mr. Alexander Siemens before the North of England Institute of Mining and Mechanical Engineers, in December last. It describes fully a series of trials in the central power station belonging to his works at Woolwich, between a Willans engine (three-crank) of 300 I.H.P. and a Belliss double-acting engine (two-crank) of the same power, and running at the same speed, 350 revolutions per minute. The dynamos were apparently identical, and all the conditions appear to have been as favourable to a fair test as they can ever be in a commercial engine room. There are anomalies in the very interesting figures given, but there is no reason to mistrust their general tendency. At 270 I.H.P., the highest power used, the combined efficiency of the Siemens-Willans plant was 86 per cent., against 85·1 per cent. in the Siemens-Belliss, but at light loads the advantage of the latter was considerable.

It is instructive to notice that with increasing load, and notwithstanding its great advantage in regard to ring friction (it probably had little more than one-third as much ring friction as the other engine), the total friction of the double-acting engine rapidly overtook that of its rival, and it is evident that had trial been made at the much higher mean pressures frequently used in non-condensing stations, the advantage of the single-acting engine would have been very marked indeed. It seems possible that, although the exceedingly elegant system of lubrication adopted in this double-acting engine is effective when the pressure per square inch on the brasses is light, yet the alternating pressures of the parts begin to produce their natural effect at heavier loads. In the single-acting engine security from wear and knock is obtained by ensuring that the revolving journal shall remain always in steady contact with *the same* brass: in the remarkable double-acting engine described, an even more perfect result is perhaps obtained at *light loads* (which, however, are not of the highest importance), by providing that the revolving journal shall touch *neither* brass; but it remains to be seen whether in continuous running at heavy loads, the brasses will not relapse more or less into the condition of those of an ordinary double-acting engine. It is at least plain from the Woolwich figures that even at 270 I.H.P. the bearing friction (as distinguished from ring friction) of the double-acting engine is enormously greater than that of the single-acting engine, and the law of its increase might well repay investigation. Provisionally, it is difficult to resist the conclusion that bearing *friction*—*i.e.*, the actual rubbing of the journal upon the brass—is of small importance in engines in which the lubrication is very perfect, as in the Willans engine through its oil bath, or in the

Belliss engine through the forcing in of oil under pressure;* and that, in double-acting engines at heavy loads, the most important element of friction loss—or, it may be safer to say, of power loss—is to be traced to the knock of the journal as it changes over from one brass to the other—a source of loss which the single-acting (constant thrust) engine avoids altogether.

Passing to the results of experience with single-acting engines in the last few years, it may be well to deal separately with:—

(*a*) Steam consumption.
(*b*) Durability.
(*c*) Lubrication.
(*d*) Vibration.

Steam Consumption (*a*).—The consumption of the best-known type of single-acting engine under all loads, is known not only from the almost historic series of tests conducted by Mr. Willans, but from numerous other trials carried out at Thames Ditton. It is, however, a frequent objection that the small consumption of steam per kilowatt upon test, bears little relation to the actual consumption of coal per kilowatt sold; and doubt is often expressed whether the engine consumption does not increase with use and wear, or whether test figures are not vitiated later by variation in load. It is satisfactory to be able to answer this question. At the stations of the Westminster Company, Dr. Kennedy, F.R.S., has for a long time had accurate records kept of the quantity of water supplied (by meter), as well as of the load upon each engine separately. The "Thames Ditton" consumption for every engine at all loads is, of course, known, and has been compared with the actual consumption, and after allowance for steam known to be condensed in pipes and used in pumps, &c. (mostly ascertained by experiment), the result is *an almost exact balance*. Probably there really are unrecorded losses for which a margin would have to be provided, if it were not that the engines work at a little less than the calculated consumption, since the latter is, of course, based upon the trials of the same engines at the makers' works, when new and stiff. Some of the engines at the stations had been at work for over five years, and few for less than two years, so all had had time to bring the rings and other wearing surfaces into the best condition for economy.

At the meeting of the Institution of Mechanical Engineers on April 24th, 1895, the above facts were well shown in a diagram exhibited by Mr. G. M. Clark. Two cases were taken from the same station: one for a heavy winter load, covering 24 hours; the other for a week's load in summer. The leading particulars were:—

	Winter load (24 hours).		Summer load (one week).	
Output in kilowatt hours	3,350		9,000	
	lbs.	lbs.	lbs.	lbs.
Measured total water consumption per kilowatt hour	...	46	...	48
Measured steam consumption of engines at Ditton trials (full load, non-condensing) per kilowatt hour	32·5		32·5	
Calculated addition to steam consumption (non-condensing) on account of low load factor ...	8·0		9·5	
Total calculated engine consumption per kilowatt hour	40·5		42·0	
Measured consumption of steam in pumps per kilowatt hour ...	1·5		1·5	
	42·0		43·5	
Balance, attributable to condensation in pipes, leaks, &c., ascertained by previous trials to vary from 7 per cent. to 11 per cent. of total consumption	4·0		4·5	
		46		48

These figures may be commended to those gentlemen of the technical press who tell us that theory never helps anyone; that no engine builder knows within pounds what weight of steam his engine is likely to use in practice; and who apparently reckon no man practical if he knows the reason for what he does or is able to foresee the result.

It is important to inquire whether the economy of the single-acting engine may be expected to make any notable advance beyond the results hitherto obtained. A new series of engines has been designed in which the necessary greater expansion is provided for, the ratio of the cylinders being altered at the same time; and in which a number of minor improvements, tending to the suppression of petty losses, considerable in the aggregate (but much less important in a non-condensing than in a condensing engine), have been introduced.

* If the mere rubbing of the journal and brass together, at heavy loads, were seriously important in a thoroughly-lubricated engine, the Willans engine would show increasing friction at heavy loads. It does not do so, and even the moderate increase (in engine and dynamo together) shown in the figures extracted from Mr. Siemens's paper, is exceptional. The increase in the Belliss engine, therefore, can hardly be due to this cause, and other reasons must be found for the increase which undoubtedly occurred.

From these engines, which have but just commenced to find their way into station work, great economy may be expected. The earliest was a triple-expansion mill engine, indicating up to about 500 H.P., driving the flax mill of Messrs. Gunning & Campbell, Limited, at Belfast, at 300 revolutions per minute, and in some very complete trials carried out last year by their consulting engineer, Mr. A. Basil Wilson, M.I.M.E., after the engine had been at work for about six months, a consumption of 12·48 lbs. of steam per I.H.P. was recorded. This places the single-acting engine, to say the least, in the very foremost rank of economical motors.

It may be remembered that in Mr. Willans's paper on "Non-condensing Trials," figures were given for one condensing trial at 170 lbs. pressure, carried out with the same triple-expansion engine as had been used for the non-condensing trials; the consumption was 15·1 lbs. per I.H.P. per hour. With the old engine that result had not been much improved upon, so it may be reckoned that the new series are about 15 per cent. better in steam economy than the old, *when condensing*. For non-condensing work, and for condensing work in special cases, the old series engines are still the most suitable, while from the smaller cylinder capacity they are less costly to make. The engine at Messrs. Siemens's works at Woolwich, the trial of which against a Belliss engine has been before referred to, was of the old pattern, compound, but fitted with the "transfer" arrangement; in other respects it was of the proportions now recognised as suitable for non-condensing only. The steam consumption at full load is given by Mr. Siemens, in his paper before quoted, as 19·5 lbs. per I.H.P., against 22·4 lbs. in the double-acting engine. It is understood that these figures of steam consumption are based upon the total water actually supplied to the boilers, with a deduction only for steam used in pumps; they presumably include pipe condensation and leakages of all kinds, and it is probably from some such causes, rarely absent from a commercial engine-room, that the water used comes out some 2 lbs. per I.H.P. per hour above that due to the proper steam consumption of the old type Willans engine at the load and pressure stated. (The vacuum is not given.) Of course the Belliss engine was similarly affected.

It may be thought at first that the large number of small cylinders, and multiplication of parts, must lead to increased weight and cost, as well as to difficulty in dismantling and overhauling. As to weight, it is almost certain that it is not increased. Cylinders weigh roughly in proportion to volume, but the weight of a piston tends to increase faster than the area; three pistons, each of 1 square foot area, will weigh less than one of 3 square feet area. To cylinder covers the same consideration applies. Piston rods, connecting rods, and crankshaft should be unaltered. There may be some saving in machine work, but small pieces are after all easier to machine than large ones, and pieces which are made in batches of, say 36, are more economically manufactured than larger pieces made in batches of 12 only. Then the identity of the several lines of parts, and their interchangeableness, are often helps to the user (especially in case of repairs), while the lightness of the individual pieces, and the regular and simple routine in removing them, make dismantling easy.

Durability.—The makers of the Willans engines have for some years past lost no opportunity of obtaining and recording exact measurements of wear, where they have been called in to carry out overhauls or examinations. The results are systematically recorded, and they show, speaking generally, an absence of wear beyond all claims made or expectations formed by those interested in the engine. On March 9th, 1895, for instance, a G.G., or 80 I.H.P., compound non-condensing engine, No. 906, used for lighting one of the largest hotels in London, and stated to have run (at about 400 revolutions per minute) for 14 hours per day, including Sundays, was taken down for overhaul—never having been so much as taken down for examination since its erection in April, 1890, that is, *five years* previously. The report states that "all parts were carefully measured, and the H.P. and L.P. trunks showed no perceptible wear, and were replaced the same as they were taken out. On measuring the H.P. cylinders, we found they were $\frac{8}{1000}$ths of an inch larger than our standard size, and the L.P. cylinders were the same; still they were quite round. All piston rings and gland rings were replaced without any repairs whatever. The whole of the repairs to this engine, including taking down and re-erecting, were executed in 24 hours."

When the single-acting engine has run n years, it is always open to objectors to say (as they do) that no doubt it is good for n years, yet $n + 1$ years will finish it. The argument admits of no refutation; that is, the present objectors may be right—for a year, though those of last year are refuted already. But reasonable men with such evidence as the foregoing before them will pay more heed to the counter-claim, which is, that the durability of the high-speed single-acting engine is not inferior to, but enormously exceeds, that of the best double-acting engines, unless the latter revert to an archaic slowness of running, in which case their enormous size and cost will exclude them from practical consideration.

Lubrication (*c*).—Where the parts of an engine lie permanently in the lubricant, both when running and when standing, the quality of the oil is of more importance than where it is used in the old-fashioned way. Free acid in oil, which is more common than is usually supposed, leads to corrosion, and in some few cases has caused serious trouble; the quest for a perfect crank chamber lubricant, which shall always be the same, is not quite ended yet. Cylinder lubrication has long ceased to trouble (if the user does not sacrifice everything to cheapness), but not so the other. Sometimes it would appear that acid is brought over in priming water from the boiler; in some cases it has been traced, with tolerable certainty, to special boiler compositions containing acids, which may find their way with priming water past the valves into the crank chamber. The tests for acid, however, are comparatively easy, and its presence is soon shown by the rusty red colour which the lubricant begins to assume, and, in worse cases, by the condition of the parts. Prevention also is usually easy, as by the use of small quantities of soda, or

of soft soap, added daily to the crank chamber in very minute quantities; if there is much of it, it "lathers" so successfully that it drives everything else out of the crank chamber. The "personal equation" enters much into this, as into other questions of engine management. There are many hundreds of closed engines running where trouble with lubrication has never been heard of; yet in a few, working apparently under identical conditions, everything is different. Where oil is of doubtful quality, temperature plays, or may play, an important part, and the advantage of keeping the crank chamber cool has for some years been recognised. In the Willans engine, cooling pipes are usually fitted in the crank chamber, through which, if the engine works non-condensing, it is well to run a small stream of water; about one-fourth of the quantity which is supplied to the engine as steam per hour is generally enough, but it is sometimes a convenient plan to run all the feed water through. In a non-condensing engine the crank chamber is hotter than in a condensing engine, because the main source of heating is conduction, by the walls of the crank chamber, from the "exhaust chamber" above. When the exhaust temperature is about 215°, as in a non-condensing engine, the crank chamber, of course, grows hotter than where the exhaust is at condenser temperature. 170° Fahr. is a perfectly safe temperature for the crank chamber, but the lower it is, the more one has, so to say, in hand, and it is such an advantage to have complete control over the temperature, that it is generally worth while to adopt the cooling pipes, even in condensing engines.

Vibration (*d*).—The increase of town lighting stations gives great importance to this subject, but it has recently been somewhat fully dealt with, as regards both engines for lighting stations and marine engines, in a paper contributed by the author jointly with Captain Sankey, R.E., to the Institution of Naval Architects.

In a recent well-known case, several single-acting engines, supposed to be remarkably free from vibration, have been removed from a London station, and replaced by steam turbines, as the only certain means of meeting the objections of persons living close by. What was the cause of the vibration, and how can it be avoided, without abandoning altogether the accepted reciprocating form of steam engine?

The station contained ten engines of 200 I.H.P. each, and it is no exaggeration to say that a person standing on the great concrete block which formed the foundation for all the engines, could scarcely tell whether those near him were running or standing. Yet complaints from houses at some little distance (rather than from closer neighbours) were evidently well founded. The engines had two cranks each, 190° apart, where there is an obvious couple, which tends to set the engine rocking endways, and to give rise to vibration. But it was incredible that the huge block of concrete, measuring 88 feet by 24 feet by 7 feet, could be tilted crossways by the couple between sets of pistons moving in lines only 2 feet 3 inches apart. Besides, the effects produced, and the known nature of the subsoil, led to the belief that the block was not so much rocking as lifting up and down bodily, and acting like a pump upon the water-laden soil below (the complaints were most serious after periods of heavy rain).

It was concluded that if three-crank engines were substituted for the two-crank engines, the vibration difficulties would be ended, but the engineer of the lighting company naturally hesitated to adopt a remedy based chiefly upon calculation, for, although such three-crank engines were running elsewhere, and with remarkable absence of vibration, there was nothing to show with absolute certainty that the mathematical reason was the right one. He therefore shifted the engines to another station, and put down steam turbines instead, feeling sure that they would at least secure the object of getting rid of vibration. The result was naturally to give an impulse to the use of three-crank instead of two-crank engines for lighting stations.

Two double engines, with six cranks of two groups, are now under construction for a large London station, but inasmuch as longitudinal stiffness is amply provided by the concrete foundation, it is unnecessary to place the two groups of cranks in one crank chamber. Each set consists of two I.I.I.—S engines, each of 360 I.H.P., and each engine coupled to a dynamo. The engines are to stand end to end, the bases being bolted together, and the crank-shafts connected by a detachable coupling (the governors are driven by gearing, so as not to interfere with the coupling). Either engine may be used, for light loads, as a single unit up to 360 I.H.P., in a form little likely to give rise to vibration, while at full power, when under ordinary circumstances vibration might become more serious, it is hoped that by special coupling together it will be entirely got rid of.

Numerous proposals have been made to balance engines by "bob weights"—dummy pistons driven by eccentrics. The couples in an engine can be thus balanced; not the other forces, unless the bob weights are placed below, and are as heavy as the pistons. The subject is, however, far too complicated to receive more than superficial notice here.

There is no subject about which more confusion exists in engine rooms than the relative parts played by the governor and by the fly-wheel. They are certainly closely allied, but very often when the governor is blamed, it is really the fly-wheel which is in fault, that is to say, with reference to the particular work the engine is called upon to do. On the other hand, many a governor owes its reputation to the fly-wheel, whose huge weight forbids the engine to take serious notice of a change of load, until the governor, possibly in itself neither a powerful one nor a good one, has had time to adapt itself to changed conditions. Of course, a heavy fly-wheel cannot affect the permanent change of speed due to a change of load, but it depends largely upon the fly-wheel whether the momentary variation shall be great or not.

The great question of throttling *versus* variable expansion has been fully dealt with by Captain Sankey in a paper read at the spring meeting this year of the Institution of Mechanical Engineers. It must suffice to say here that variable expansion is desirable for practical convenience, rather than for economy, in a great many cases, and for economy in some, but that in no ordinary case does the economy rise beyond a very moderate percentage, and that only through a small part of the range of variation of load. It is also established, upon the basis of Mr. Willans's experiments, that at very light loads (say quarter load, or even more) it is distinctly more economical to throttle the steam than to continue to make the cut-off earlier, and maintain the full pressure in the steam chest—since in the latter case, for only a small useful load, the full initial condensation is maintained, and the full loss by radiation. When the initial temperature in the first cylinder is reduced (as it is by throttling), both these sources of loss are diminished. Perhaps the most useful effect of automatic gear is that, by its aid, an engine can be occasionally overloaded without having to carry the same late cut-off at all times. Where the normal load is also the maximum load (as it should be in lighting stations, where the plant works in parallel) the engine is, of course, designed to give that load economically, *i.e.*, with cylinders of such size as to give the full load at a moderate mean pressure. In this case when light loads are carried—if they ever are carried: it would be better to avoid them—it is not of much importance whether the power is reduced by throttling or by altering the expansion. Now take such a case as that of electrical traction, where the average load is small, perhaps only half or two-thirds the maximum; it is evident that the cylinders, and the normal expansion, should be designed to suit the average load—but this cannot be done without the use of automatic expansion, because provision has to be made for the occasional overload. By automatic expansion it is possible to keep the cylinders of such an engine small, and suitable for the normal load, and yet readily take more power from it for short periods. The periods of overload are, of course, wasteful; but this is far less important than wastefulness during the much longer periods of average load.

The mode of varying the cut-off in the Willans engine is by a sleeve working upon the trunk or hollow piston rod, where it passes into the steam chest at the top. There are inclined ports in the trunk and in the sleeve, and by rotating the latter by means of gear outside (or sometimes inside) the steam chest, the cut-off is made early or late.

USES OF ACCUMULATORS.*

By J. C. HOWELL.

The first uses to which early accumulators were practically put was for maintaining continuity of supply, or what is now called constant service in country house electric lighting work. In the very early days of electric lighting, it was discovered that in this class of work it was essential that the light should be available any hour of the day or night, and that people were prepared to pay considerable sums for the use of an apparatus which would give them this regularity of supply, and so avoid the necessity of keeping a man or men continually looking after moving machinery. Although the capital cost of these early accumulators was exceedingly high, it was speedily found that the annual saving effected by their use was sufficiently large to recompense the purchaser for his outlay, except in cases where water power was available. In gas engine work, and with steam engines, the accumulators were found to be working at their best efficiency at a time when, had the motorial plant been in operation, it would have been working at its worst efficiency, and instances are recorded where, by the adoption of accumulators, the gas bill had been reduced to 50 per cent. of what it was when the supply of electricity for household service was obtained from the dynamo driven directly by the engine, and this difference in a case where the former supply had not been constant service.

Unfortunately, the construction of these first accumulators was defective, and for a while accumulators became discredited, owing to the frequent breakdown of the plates, of which they were composed, and the falling away of the active material which permitted, what we shall call, the storage action to take place. By slow degrees these faults in construction were discovered and remedied. Then a more abstruse series of faults developed, viz., those due to the peculiarity of the chemical actions, which were going on in the cell, and which required time to show themselves. These too, in turn, were carefully investigated by earnest men, who devoted their lives to research, until at last, by the law of the survival of the fittest, manufacturers were able to produce accumulators which they were prepared to guarantee and maintain for a series of years.

During this period, other departments of electrical industry had not been idle, and the electric light had become so popularised that central stations were established for the supply of electricity. The public were at first contented with a supply which would suffice for the ordinary hours of lighting, but, as they began to appreciate the benefits of the new illuminant, they were not content with a partial supply, but required it at all hours of the day or night, and men's minds were directed to find some means for providing this supply in an economical way. Had the public been content to maintain their demand for lighting at a normal rate whenever they required it, it would have been easy for the central stations to supply electricity in an economical manner, but the public, proverbially fickle, required their supply in an extraordinary fashion. At certain periods of the day they were content to ask for only some 1 per cent. of what their normal demand was, and moreover required that the supply at this

* Paper read before the Northern Society of Electrical Engineers, May 13th, 1895.

period should not be charged for at a higher rate than when the demand was just 100 times in excess. Although it had struck many longsighted engineers that the public supply of electricity would have to be dealt with finally in much the same fashion as the public supply of water or gas had been dealt with, no one had realised how greatly the demand for lighting at different times of the day varied, and the ordinary engineer greeted the publication of the first load curve of a central station that was published with a smile of wondering bewilderment. Such curves, in the after history of electric lighting, became common, and comparisons were instituted between curves obtained for various districts, various cities, and various countries, and it was found that there was a very considerable amount of uniformity throughout the world. In process of time the different characteristics of the load curve for summer and winter were established, and it became more and more evident that, unless some satisfactory means of providing for this inequality of demand was discovered, electric lighting would for ever remain a luxury.

The accumulator manufacturers considered that they held the key to the solution of the difficulty, and at Colchester set down a system which was intended to demonstrate to all the world that the difficulty had been satisfactorily met. The problem was, however, unfortunately tackled by men who were probably thoroughly conversant with the batteries manufactured at the time, but had very little knowledge of the public needs, and after some years' work, the scheme had to be abandoned, and other methods tried. The scheme had, however, in showing the difficulties to be encountered, shown also considerable promise for the future, and it was discovered that accumulators, to be of real service in central station work, had to be capable of meeting, for short periods, demands considerably in excess of their normal capacity. This was difficult of attainment, as, owing to the chemical actions taking place on the plates which formed the active portion of the accumulator, any supply of electricity drawn at too rapid a rate would tend to break down the materials which composed the plate, and furthermore, did not provide sufficient time for the electrolyte to diffuse itself so as to keep up the chemical reactions involved in the supply of electricity. This fact being properly appreciated, speedily led to the development of accumulators, which could, on being called upon, discharge at very rapid rates, and although these accumulators were costly, it was discovered that their freedom from breakdown in trying circumstances was such as to warrant a trial being made on a sufficiently large scale, to see whether this new form would be fully equal to all the requirements of central station practice. Reliable statistics, too, were at this time available, so that engineers could fully realise the costs of working under the peculiar conditions which the public demanded, and it was found that the cost of fuel was from four to six times what had been expected from the results obtained when working an engine and dynamo under test. The facility with which electrical measurements could be made had trained men's minds for the investigation of the various losses occurring in the transformation of energy, and central station engineers became more and more aware of the necessity of dealing with all these losses, so as to enable them to compete on more and more favourable terms with other systems of illumination that had been in vogue.

A discussion upon these sources of loss, and the way in which by the use of accumulators, these losses can be minimised, is my real object, and to make matters clearer, I have placed before you to-night curves of the efficiency of a steam driven dynamo at various loads, from which you will see that the quantity of water required to be evaporated per unit working at 20 per cent. of its load is more than twice as much as when it is fully loaded, the figures being 33 lbs. of water per unit at full load, and 73 at ¼th load.

NON-CONDENSING WILLANS SET.

Engine load factor.	Lb. of coal per unit.	Cost per unit of coal at 20s. per ton.
20 per cent.	7·3	·78d.
30 "	5·4	·57d.
40 "	4·75	·5d.
50 "	4·3	·46d.
60 "	4·	·43d.
70 "	3·75	·4d.
80 "	3·5	·37d.
90 "	3·4	·36d.
100 "	3·3	·35d.

Similar engines, when dealing with the business of supply, have been tested by Prof. Kennedy at actual work, and he has been good enough to publish his results. These results I have embodied in a table, to which I shall refer you, and I have amplified them somewhat so as to give us sounder ideas of what the figures actually mean by attaching a value to the ton of coal. This value may appear high to you in this district, but it is the price that rules in London, where at the moment there is a greater production of electrical energy for lighting purposes than in all the rest of the United Kingdom put together. Moreover, it is a comparatively easy matter to mentally reduce the figures of the table based on a standard price of 20s. per ton to the figure which rules in each investigator's district.

Take as an example of the use of Table I. that we have a 100-unit steam dynamo running at maximum efficiency. It will need under the most perfect conditions of running 3·3 lbs. of coal per unit per hour, or 330 lbs. Increase the load upon our station 20 per cent., and we have to start another similar set, so that the load is divided between them, each set is now working at 60 per cent. load factor, the amount of coal consumed is 4 lbs. per unit, or 480 lbs. Thus an increase of 20 per cent. in the load involves an increase of 45 per cent. in the coal consumption, and the actual loss owing to the decrease in efficiency is 9½d. per hour in the coal bill alone as long as the 20 per cent. extra load is maintained. That these losses are real and are actually found to exist in practice, we will at once discover

KENNEDY TABLE OF CONSUMPTION ON VARIABLE LOADS.

	11 a.m. to 6 p.m.	6 p.m. to midnight.	Midnight to 11 a.m.	Whole day.
Time	7 hrs.	6 hrs.	11 hrs	24 hrs.
Total I.H.P. hours ...	562	1,366	407	2,335
Total E H.P. hours ...	400	979	260	1,639
Units generated ...	293	731	193	1,217
Coal consumed... ...	3,838 lbs.	4,459 lbs.	2,547 lbs.	10,844 lbs.
Coal per unit	13·1 lbs.	6·1 lbs.	13·2 lbs.	7·33 lbs.
Coal at 20s. per ton ...	1·4d.	·65d.	1·41d.	8d.

by reference to the Kennedy table, where we find that there was less coal burned during the period of heavy load than during the period of lighter load, that in fact 63 per cent. of the total amount of fuel consumed was used to provide 33 per cent. of the output. It will be of interest if we examine this table closely. The day on which these tests were taken was divided into three parts, closely corresponding with the times as shown on a load curve where you have a minimum demand, moderate demand, and maximum demand. You will notice that the amount of coal required for the moderate demand approaches very closely to the total amount required for the maximum demand, and that during the period of minimum demand when only some 20 per cent. of the maximum output was delivered, the coal bill reached the respectable figure of 57 per cent.

(To be continued.)

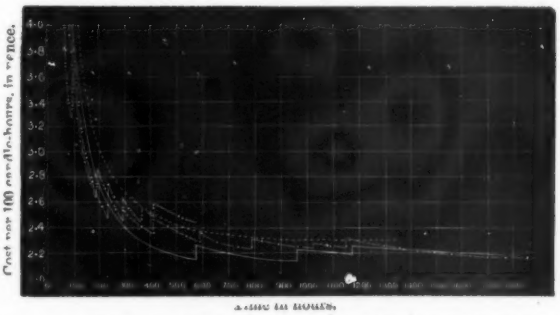
TESTS OF GLOW LAMPS, AND DESCRIPTION OF THE MEASURING INSTRUMENTS EMPLOYED.*

BY PROF. W. E. AYRTON, F.R.S., AND E. A. MEDLEY.

(Concluded from page 631.)

Although, then, the rise in candle-power during the early part of the life of a glow lamp is apparently not an absolutely new fact, the magnitude of the rise and the effects resulting from it were, in the older lamps, so trifling, that no special attention seems to have been devoted to this important subject in the former reports of tests of lamps. Indeed, even in a prominent book connected with glow lamps which has quite recently been brought out in this country, no mention whatever is made of the fact in question. And yet, as we have already shown, and as will become more apparent from what follows, this remarkable rise in the candle-power during the earlier part of the life of an Edison-Swan lamp has a very important effect on the economy of lighting with glow lamps.

The next point to consider is the way in which the cost of lighting with the modern 100—8 Edison-Swan lamps depends on the pressure at which they are run, and on the cost of a Board of Trade unit. The curves on figs. 12 and 13 give the cost of obtaining light with the



——— Lamps run at 100 volts.
— — — — Lamps run at 101 volts.
—·—·—·— Lamps run at 102 volts.
— — ·— — Lamps run at 104 volts.

The breaks in the curves connected by perpendicular lines show the sudden rise in price due to a lamp breaking and a new one being substituted.

Price of a Board of Trade unit 4½d. Cost of a new lamp 1s. 9d.

FIG. 12.—LIFE TESTS ON EDISON-SWAN 8-C.P. 100-VOLT LAMPS. CURVES SHOWING THE RELATION BETWEEN COST OF LIGHT AND TIME.

various groups of lamps, including the cost of replacing lamps with broken filaments, calculated day by day from our tests as the experiment went on.

* Paper read before the Physical Society, January 11th and 25th, 1895.

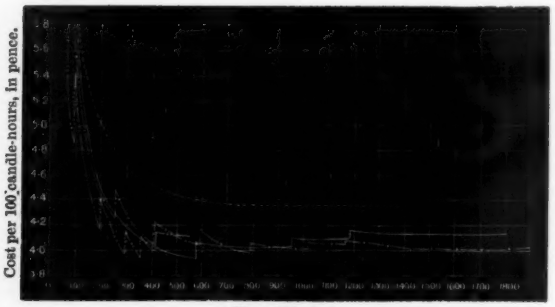
The ordinates of the curves show the cost of 100 candle-hours at any time during the test, time being measured horizontally, and the values of the ordinates have been calculated from the following formula:—

Total cost per candle per 100 hours at the end of any number of hours, t, equals

$$100 \times \frac{\text{Board of Trade units used during time } t \times \text{price of one Board of Trade unit}}{\text{Total candle-hours during time } t}$$

$$+100 \times \frac{\text{Number of lamps used during time } t \times \text{price of one lamp.}}{\text{Total candle-hours during time } t}$$

The price of a kilowatt-hour we took as 4½d. in fig. 12, and as 9d. in fig. 13, the cost of a new lamp being taken at 1s. 9d. in both sets of curves.



Time in hours.

——— Lamps run at 100 volts.
– – – – – Lamps run at 101 volts.
—·—·—·— Lamps run at 102 volts.
—··—··—·· Lamps run at 104 volts.

The sudden breaks in the curves connected by perpendicular lines show the sudden rise in price due to a lamp breaking and a new one being substituted.

Price of a Board of Trade unit 9d. Cost of a new lamp 1s. 9d.

FIG. 13.—LIFE TESTS ON EDISON-SWAN 8-C.P. 100-VOLT LAMPS. CURVES SHOWING THE RELATION BETWEEN COST OF LIGHT AND TIME.

Of course, it will be seen from the formula quoted above, that whenever a lamp breaks and a new one is put in its place, there must be a sudden, though temporary, rise in the cost per candle-hour due to the cost of the new lamp; but this rise becomes less marked as the number of lamps included in the calculations increases, and would have become inappreciable if the tests could have been carried on for a sufficient length of time.

The first three lamps to break in both the 102 and 104-volt groups were replaced by the lamps which we had previously run at 102 and 104 volts respectively for 110 hours; and in calculating the cost-curves we have added in the watt-hours and the candle-hours due to these previous runs; we have also added to the abscissæ of the curves the 110 hours.

On examining the total-cost curves on figs. 12 and 13, it is at once apparent that they nowhere show any such rise in the cost of producing light, as was seen in the similar curves for American lamps (fig. 5). The curves in fig. 12, for which the price of a Board of Trade unit was taken as 4½d., do *not* turn up *at any* point, not even for the three lamps run at 101 volts, which lasted unbroken for over 1,300 hours.

In fig. 13, however, for drawing the curves on which the price of a Board of Trade unit has been taken at 9d., there are slight indications of the curves turning up: for example, the curve for the 100-volt group rises a little at 850 hours, at which time the lives of the three lamps being tested were 850, 850, and 278 hours; and, again, at about 1,600 hours, when the lives of the three living lamps were 1,028, 643, and 433 hours, the cost per candle-hour rises a little. In the group run at 101 volts, the cost of lighting began to rise a little after the lamps had been lit for 1,100 hours; and in the 102-volt group the curve (fig. 13) turns up a little at 1,700 hours, at which time the ages of the lamps alight were 928, 678, and 552 hours. But at no one of these points is there a sufficient rise to indicate that a time has been reached when it would be good economy to discard lamps.

The remaining total cost curve on fig. 13, viz., that for the group of lamps run at 104 volts, when the price of the Board of Trade unit is taken at 9d., does not show any indication of a minimum point.

Hence, generally, we may conclude that when the modern Edison-Swan 8 C.P. 100-volt lamps such as we have been testing, costing 1s. 9d. per lamp, are supplied with energy costing 9d. per Board of Trade unit, no economy will be gained by discarding the lamps before the filaments break.

This important result is, of course, due to the fact, already pointed out, that there is no marked decrease in the candle-power of the lamps during their lives.

Owing to the extent to which the individual lamps varied among themselves, it is difficult to say which of the four pressures at which we tested lamps would be the most economical to use. The three lamps tested at 101 volts seem to have been quite abnormal, their efficiency being very low, and, as a consequence, their lives very long.

With a Board of Trade unit costing 4½d., the lamps tested at 100 volts gave the cheapest light, and as they do not seem to have been above the average in quality, this result may probably be safely taken as correct.

With energy costing 9d. per Board of Trade unit (fig. 13), there does not seem much to choose between the total cost of producing light with the three pressures of 100, 102 and 104 volts, excepting that the use of 104 volts would introduce an extra expense arising from the labour of frequently replacing broken lamps.

The two conclusions, then, to which we are led by a study of these total cost curves on figs. 12 and 13 are:—

1. The modern Edison-Swan 8 C.P. 100-volt lamps, such as we tested, should not be discarded until the filaments break.

2. No marked economy can be gained by over-running this type of lamp.

Addition made January 25th, 1895.

The question arises, what is the cause of the marked rise in candle-power which occurred with all the lamps tested by us during 1893 and 1894? In the early summer of 1894, when our tests were approaching completion, Mr. Howell, in contributing to a discussion at the American Institute of Electrical Engineers, stated that such a rise in candle-power was due to the vacuum of the lamp improving during the early part of its life. Therefore, after we had stopped the main investigation, we made some experiments to test the validity of Mr. Howell's explanation.

We applied the induction coil vacuum test to some dozen Edison-Swan lamps when quite new, and again after they had been run for about 80 hours at their normal pressure of 100 volts. In *every case* we found that the vacuum had apparently improved; for using a spark of about 8 millimetres in length, the lamps when *new* were entirely filled with a bright blue glow accompanied with some bright white patches on the glass; whereas, after a run of about 80 hours at a pressure of 100 volts, this phosphorescent effect with the 8-millimetre spark was either entirely absent, or consisted of only a faint nebulous glow which did *not* fill the lamp bulb, and there was very little light on the surface of the glass.

Thus it appeared as if Mr. Howell's explanation of the great increase in the light given out by a glow lamp during the early portion of its life was correct.

But this conclusion that we arrived at last year has been modified by tests which we have been carrying out on Edison-Swan glow lamps purchased after our paper was sent in to the Physical Society in November, 1894. For we find that—while the induction coil vacuum test applied to these lamps when they are new, and after a run of 80 hours at the normal pressure of 100 volts, shows that the vacuum apparently improves—this improvement in the vacuum is not accompanied with the great rise in candle-power which we found with all the Edison-Swan lamps purchased in 1892 and 1893, the tests of which form the subject of this paper. And yet the lamps are all marked in the same way, "100 E.F. 8," and they all look alike.

In the case of a set of these Edison-Swan lamps purchased on January 21st, 1895, not merely was the current and the light periodically measured, but the induction coil vacuum test was applied at intervals during the 80 hours' run; and it was found that the change in the phosphorescent appearance of the lamp, and the consequent apparent increase in the vacuum, was produced slowly and not suddenly on the first application of the pressure of 100 volts.

The Table shows the results of the tests of this batch of six lamps. The light was measured with a Harcourt-Pentane standard, the potential difference with the Ayrton and Mather reflecting electrostatic voltmeter, and the current with the strip of manganin shunted with the Ayrton and Mather moving coil galvanometer; this voltmeter and the ammeter combination being the same as those employed with all the lamps tested previously. But both instruments were carefully calibrated on January of this year, to make quite certain that the different behaviour of these newer lamps was not merely an apparent one produced by some change having occurred in the sensibilities of the measuring instruments.

The insulation of the lamp-holders was carefully cleaned and the contact surfaces scraped before these tests were made.

From these tests it is seen that, in the case of lamps Nos. XI. and XIV., there was practically no change either in the light or in the power absorbed during the first 80 hours of the running at the constant pressure of 100 volts; and that in the case of the remainder of this batch of lamps the increase in the light and in the power absorbed was comparatively small, the greatest change being with lamp No. XII., where the light rose by about 11 per cent., and the power by about 4 per cent. This is a very different result from that obtained with the Edison-Swan lamps previously tested, and run at a constant pressure of 100 volts, for there the total light given out by the three lamps together rose by 35 per cent. in the first 100 hours of running, and the power by 7·55 per cent.

Since, then, as already stated, the vacuum, when tested periodically with the induction coil, appeared to improve steadily with each of the six lamps Nos. IX. to XIV. during the run of 80 hours, it would appear that improvement in the vacuum was *not* the sole cause, as Mr. Howell stated, for the great rise in the candle-power such as we observed with all the Edison-Swan lamps which we tested in 1893 and 1894.

It is possible that this rise in candle-power may be due to a change in the surface of the filament, causing the emissivity for heat to decrease, since that would raise the light emitted, as well as the number of candles per watt. Whether such a change in the heat-emissivity of the filament occurs with time we have not yet found out.

Another point of difference between this batch of six lamps, Nos. IX. to XIV., and those which we tested during the main part of our investigation, is the relative inefficiency of these six lamps. For in no single test at any time during the 80 hours run with these

Six Edison-Swan Lamps, marked "100 E.F. 8," purchased January 21st, 1895, marked by us IX., X., XI., XII., XIII., XIV.

Filaments placed at an angle of 45° with the Photometer-Bench.

Hours of running.	Power in watts.	Candle-power.	Watts per candle.
Lamp No. IX.			
0	41·3	9·70	4·26
1 hour 40 minutes	41·3	9·70	4·26
6 hours 10 minutes	41·5	9·70	4·28
13 hours 30 minutes	41·6	9·67	4·30
42 hours 30 minutes	41·9	9·85	4·25
80 hours	42·5	9·85	4·31
Lamp No. X.			
0	40·35	7·85	5·14
1 hour 45 minutes	40·4	7·95	5·08
6 hours 15 minutes	40·5	7·92	5·11
13 hours 35 minutes	40·6	7·92	5·12
42 hours 35 minutes	40·9	8·2	4·99
80 hours 5 minutes	41·5	8·5	4·88
Lamp No. XI.			
0	39·8	7·89	5·05
1 hour 50 minutes	39·8	8·00	4·97
6 hours 20 minutes	39·8	8·11	4·91
13 hours 40 minutes	39·8	7·95	5·01
42 hours 40 minutes	39·8	8·00	4·97
80 hours 10 minutes	40·1	8·00	5·01
Lamp No. XII.			
0	39·85	7·78	5·12
1 hour 55 minutes	40·1	8·07	4·97
6 hours 25 minutes	40·25	8·05	5·00
13 hours 45 minutes	40·41	7·95	5·08
42 hours 45 minutes	40·75	8·3	4·91
80 hours 15 minutes	41·4	8·7	4·76
Lamp No. XIII.			
0	40·75	8·06	5·05
2 hours	40·6	8·06	5·04
6 hours 30 minutes	40·5	8·17	4·95
13 hours 50 minutes	40·5	7·85	5·15
42 hours 50 minutes	40·5	7·9	5·13
80 hours 20 minutes	40·6	8·4	4·67
Lamp No. XIV.			
0	41·2	8·49	4·85
2 hours 5 minutes	41·2	8·65	4·76
6 hours 35 minutes	41·2	8·65	4·76
13 hours 55 minutes	41·2	8·49	4·85
42 hours 55 minutes	41·2	8·6	4·80
80 hours 25 minutes	41·5	8·5	4·89

six lamps were the watts per candle less than 4·25, and in many cases they were over 5; while with lamp No. XIII. the watts per candle, as seen in the last table, were as high as 5·15 after this lamp had been run for 13 hours 50 minutes. It is possible, then, that when in the body of the paper we spoke of the group of three lamps which we ran at a constant pressure of 101 volts as being "quite abnormal," because the average watts per candle required with this group during the run of 1,340 hours were as high as 4·68, we ought rather to have spoken of the various other groups of lamps which we ran at the constant pressures of 100, 102, and 104 volts respectively as being abnormally good Edison-Swan lamps.

At any rate it is clear that it is at present impossible to state the most economical potential difference to employ with any Edison-Swan lamps marked "100 E.F. 8;" since batches of lamps so marked, and therefore nominally the same, really require very different potential differences to be employed to obtain maximum economy with a given price of lamp and of a kilowatt-hour.

It may, however, be concluded, from the curves shown in figs. 12 and 13, that the most economical potential difference to employ with any Edison-Swan lamps marked "100 E.F. 8," such as have been obtainable in the open market since 1892, is the potential difference that will cause the lamp during a large portion of its life to have an efficiency of about 0·25 candle per watt, corresponding with 4 watts per candle.

The value of this potential difference for any batch of these lamps may be determined approximately in the following way. From our tests, already referred to, of 11 Edison-Swan lamps, marked "100 E.F. 8," which had been used in a house for some 200 or 300 hours, we found that the relation between candle-power and pressure was given by

$$\text{Candle-power} = a \times (\text{volts})^{5\cdot91},$$

where a is a constant. Also we found that the relation between candle power and watts for these lamps was given by.

$$\text{Candle-power} = b \times (\text{watts})^{2\cdot9},$$

where b is a constant. Therefore

$$\text{Volts} = c\,(\text{watts per candle})^{-0\cdot338},$$

where c is a constant.

Hence, if one has a batch of Edison-Swan lamps marked "100 E.F. 8," whose efficiency is, say, 0·222 candle per watt, corresponding with 4·5 watts per candle, when a pressure of 100 volts is applied to them, it would be probably most economical to run them at about 103 volts, since this is the pressure which the last equation tells us will be necessary to raise the efficiency of such lamps to 0·25 candle per watt.

From what precedes, it follows that, since the average efficiency of the 100 E.F. 8 Edison-Swan appears to be less than 0·25 candle per watt, the opinion expressed by one of us in an article entitled "New Lamps for Old," published in the *Electrician* for September 29th, 1893, was correct, viz., that it would be economical to overrun Edison-Swan lamps by applying a pressure about 3 per cent. higher than the marked pressure. And that the reason why this conclusion was apparently negatived by the results of the tests which we carried out during the winter of 1893 and a large portion of 1894, was because the various groups of lamps which we ran at the constant pressures of 100, 102, and 104 volts respectively consisted of specially good specimens.

In applying the rule that the economical potential difference is about the one which causes the lamp to produce 0·25 candle per watt, it is important, however, to examine 8-candle 100-volt Edison-Swan lamps when bought to see whether they are really marked "100 E.F. 8." For while the result of various purchases of 8-candle 100-volt Edison-Swan lamps during the past three years has always resulted in lamps marked "100 E.F. 8" being sent us, although the marking on the lamps was never specified by us, a recent batch of lamps that we have received contained among them certain lamps marked "100 B. 8," which not only differed in the marking but also in the filament being of a simple horse-shoe shape, and not with a loop at the top as in the case of the other lamps. And, on testing these Edison-Swan B lamps, we were surprised to find that with no one of them, when run at 100 volts, did the watts per candle exceed 3·9, and in some cases the watts per candle were as low as 3·01. We have not, however, had these B lamps for a sufficiently long time in our possession to be able to express any opinion about their life history.

NEW PATENTS—1895.

8,966. "Improvements in meters for measuring currents of electricity, part of the invention being applicable to electric motors for driving astronomical clocks and other like apparatus." H. A. Rowland. Dated May 6th.

8,967. "Improved insulating material for cables and process of making same." A. Geutzsch and J. N. Scanavi. Dated May 6th. (*Complete.*)

8,972. "Improvements in electric railways." W. Lawrence. Dated May 6th.

8,994. "Improvements in and connected with arc lamps." W. Jandus. Dated May 6th.

9,010. "Improvements in electric railways." G. E. Baird. Dated May 7th. (*Complete.*)

9,050. "An improved process for the production of lead compounds or other metallic compounds by electrical means." E. Bailey, T. Cupper, A. L. Stobbs, W. A. Wilson and J. W. Pollard. Dated May 7th.

9,056. "Safety appliance for electrical circuits." Siemens Bros. and Co., Ltd. (Communicated by Siemens & Halske, Germany.) Dated May 7th. (*Complete.*)

9,111. "Improvements in telephonic receivers." C. D. Janszen. (Communicated by A. Gerbert, France.) Dated May 8th.

9,112. "Improvements in the method of and means or apparatus for effecting multiple telephonic communications." C. D. Janszen. (Communicated by A. Gerbert, France.) Dated May 8th.

9,132. "Improvements in electrical ceiling and wall connectors." C. M. Dorman and R. A. Smith. Dated May 8th. (*Complete.*)

9,144. "Electrical soldering apparatus." G. Binswanger and F. W. Ball. Dated May 8th.

9,146. "Improvements in and connected with arc lamps." H. Niewerth and R. Niewerth. Dated May 8th.

9,158. "An electric light bath." G. F. Redfern. (Communicated by W. Gebhardt, Germany.) Dated May 8th.

9,167. "Improvements relating to telegraphic working through cable lines." J. A. L. Dearlove. Dated May 8th.

9,176. "Improvements in armatures for dynamo-electric machines." W. B. Sayers, H. A. Mavor, W. A. Coulson, and S. Mavor. Dated May 8th.

9,180. "A hand hoist for raising and lowering arc lamps." G. W. Lunn. Dated May 9th.

9,184. "An improved electric motor called the 'Leader' electric motor." J. Waddington, E. Waddington, and J. Waddington. Dated May 9th.

9,202. "Improvements in holders for incandescent electric lamps." J. M. Huisman and H. C. Gover. Dated May 9th.

9,206. "An improvement in glow lamps." H. W. Handcock and A. H. Dykes. Dated May 9th.

9,217. "Improvements in electrical cut-outs or safety fuses, switches, and the like." J. B. Verity. Dated May 9th. (*Complete.*)

9,237. "Improvements in or connected with electric conductors for telephonic or other analogous purposes." H. Edmunds. Dated May 9th.

9,257. "Improvements in cells and diaphragms for use in electrolysis." J. Hargreaves. Dated May 10th.

9,262. "Improvements in incandescent electric lamps." A. B. Mees and J. D. Pitt. Dated May 10th.

9,273. "Improvements in tubular electro-magnets." J. Taylor. Dated May 10th.

9,286. "Improvements in automatic electric switches, and in their use for distribution of electricity, parts of which improvements are applicable to other automatic devices." J. Hopkinson. Dated May 10th.

9,312. "Improvements in electric conductors or cables." H. Edmunds. Dated May 10th.

9,314. "Improvements in electric receivers or mechanism for actuating counting dials or the hands thereof." H. Lepaute. Dated May 10th.

9,323. "Heating, drying, and smoothing by electricity." L. B. Miller. Dated May 10th.

9,354. "Improvements in electric cooking and heating apparatus." G. A. Nussbaum. Dated May 11th.

9,372. "An electric oven." V. G. Middleton and D. Neale. Dated May 11th.

9,375. "Improvements in the electric propulsion of cars." A. H. Brintnell. Dated May 11th. (*Complete.*)

9,380. "Improvements in electrical firing pistols for gun mountings." E. W. Lloyd (of the firm of Sir W. G. Armstrong, Mitchell and Co., Limited) and R. T. Brankston. Dated May 11th.

9,388. "Improvements in regulating appliances for arc lamps." R. E. B. Crompton. Dated May 11th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

489. "Improvements in electric clocks." E. Herbert. Dated January 9th. The object of the invention is to provide an improved electrical or electro-magnetic clock or time-piece in which the required impulse is imparted by gravity to the pendulum at each oscillation. 4 claims.

548. "Improvements in or appertaining to working quadruplex and duplex telegraph signal receiving instruments." W. P. Thompson. (A communication by W. F. Melhuish, of Calcutta.) Dated January 10th. Consists of an electro-magnetic adjunct or "twin-transformer" designed to act in combination with, and to form an essential component part of, the quadruplex or duplex receiving instruments included in any circuit. By the combined action between transformer and signal receiving instruments, impedance effects within the receiving instruments are diminished, if not completely counteracted, by the emission of two transient currents, one an extra and the other an induced current, which are generated in the adjunctive twin-transformer by the passage through it of the primary signalling current. 3 claims.

2,105. "Improvements in arc lamps." F. Brown and C. H. Offord. Dated January 31st. The current to the carbons is carried through a wire wrapped to form a solenoid, the core of which is either directly or through a lever attached to a band of metal, leather or other suitable material, which passing round a brake wheel, to the axle of which wheel is attached a pinion, which pinion gears into a rack on the rod which carries the carbons. Upon switching on the current the core is drawn into the solenoid, tightening the band round the brake wheel and pulling the wheel round thus through the pinion raising the carbon rod and striking the arc. As the arc burns the band slackens and allows the brake wheel to turn and the carbon rods to come nearer together by gravity thus maintaining a steady arc. The pressure on the brake wheel can be varied either by the means of springs or weights as may be desired. 6 claims.

2,806. "Improvements in electrolytical decomposing apparatus." C. Kellner. Dated February 8th. The inventor arranges the electrode or electrodes at the bottom of the electrolytical vessel horizontally, or approximately so, and side by side, so that it or they constitute the bottom of the electrolytical vessel. The upper surface of the electrodes which are subject to more or less wear according to the nature of the substance to be electrolytically decomposed, is preferably covered alternately with finely and coarsely powdered carbon compressed firmly in place. 4 claims.

3,725. "Dry or semi-dry galvanic element." T. Blackhurst. Dated February 21st. Relates to a dry element in which for exciting paste are used clay gelatine and starch, and in some cases, clay without gelatine or starch, to absorb a solution of ammonia chloride and sea salt, in water. 4 claims.

4,142. "Improvements in construction of electrical letters and signs." A. R. Upward. Dated February 27th. Relates to improvements in that part of the complete electric letter, which is called the backing; and in the details of construction of same, and in the method of mounting the electric letters and devices as complete electric signs. 2 claims.

4,254. "Improvements in electric arc lamps." J. C. B. Andrews. Dated February 28th. An electric arc lamp in which the regulation of the arc is affected by an electro-magnet controlling a break band round a wheel over which also passes a bank carrying the carbons one at each end suitably held in holders and guided so that they are in line with one another in the ordinary way. 6 claims.

4,724. "Improvements in and relating to secondary batteries." O. March. Dated March 6th. The supports for the active material are constructed in part from sheets of lead or of a suitable lead alloy, perforated and corrugated in a particular manner, and in part from cast frames of lead or lead alloy. 3 claims.

5,102. "A new or improved telephonic relay." G. Gillmore. Dated March 12th. The inventor arranges a magnet opposite to the tympanum of a sound chamber or box, and places upon the magnet a coil which is included in and forms part of the first circuit from which the current is to be translated. 3 claims.

5,656. "Improvements in the production of ozone and in apparatus therefor." A. Schneller and W. J. Wisse. Dated March 17th. Consists in regulating the quantity of current employed in the transformation of currents of low tension into currents of high tension for use in the production of ozone (so as to ensure dark discharges between the discharge-surfaces), by the insertion of a specific resistance in the circuit between the transformer and the discharge-surfaces. 4 claims.

6,554. "Improvements in or additions to metallic tubular telegraph poles and metallic tubular poles for other purposes." Bullers, Limited, and E. J. Chambers. Dated April 2nd. Consists of the additions to or use with metallic tubular telegraph poles and metallic tubular poles for other purposes of interchangeable base attachments, whereby the metallic pole may be made at will either into a driving pole for rapid erection or into a pole with a buckled base plate which is sunk in the ground and earth rammed around it. 1 claim.

9,129. "Improvements in electrolysis." H. Blumenberg, jun. Dated May 8th. The object of the invention is to obtain, by electrolytic action, bromates and chlorates from the alkaline metals and the metals of the alkaline earths. 3 claims.

10,149. "Improved apparatus for supporting electrical conductors and the like." J. Orme. Dated May 25th. Consists of a casting fashioned like an ordinary railway chair, and carrying an arm to which the iron or copper strip suitably insulated therefrom is secured. The casting is slipped over the lower head of the rail in the usual manner and secured in position by a wood metal or other key. 5 claims.

14,545. "Improvements in the construction of dynamo-electric machines and electromotors." T. Parker, Limited, and T. Parker. Dated July 28th. Has for its object, firstly, to facilitate the cleaning and the removal and replacement of the armature of a two-pole single limb dynamo-electric machine or electromotor in which the armature and pole-pieces stand above or outwards from the magnet coils, and also the removal and replacement of the ferrules which carry the coils which surround the magnets; secondly to alter, with a view to facilitating their preparation, the form of certain parts of the pole-pieces which have been previously devised to enable the object above stated to be effected; and, thirdly, to improve the bearings of dynamo-electric machines and electromotors which are lubricated by means of lubricating rings. 4 claims.

20,241. "Improvements in alternating current motors." H. H. Lake. (Communicated from abroad by E. A. Clark, of America.) Dated October 23rd. Consists of a motor in which the secondary coils are in close relation with one or more masses of iron between the poles of the field magnet. 1 claim.

20,886. "Improvements in and relating to telegraphic relays." A. D. MacDonald. Dated October 31st. The method of regulating the mechanism is by increasing or decreasing the tension of a specially arranged spring, operating a suitably constructed armature lever. 7 claims.

21,549. "Improvements in electrically heated robes, towels, quilts, and other articles of flexible fabric." H. G. O'Neill and E. Jewell. Dated November 8th. Consists chiefly in a flexible robe, towel, bandage, or other article or fabric provided with electrical heating devices and adapted to be applied to the human body. 3 claims.

23,553. "Improvements in apparatus for the electrical treatment of beer or other liquid or material." L. Wagner and J. Mars. Dated December 4th. Consists in a conduit provided with opposing electrodes which limit the passage of the liquid, or other material through the conduit and spread or disperse it in a comparatively thin sheet over their opposing surfaces; it further consists in a conduit having opposing electrodes of peculiar shape, as set forth; it further consists in a conduit which is at the same a sight-glass or tube of transparent insulating material, provided interiorly with and supporting opposing electrodes; it further consists in an electrolysing device adapted to be interposed in a beer or other conduit; it further consists in certain parts and combinations thereof set forth and claimed. 13 claims.

23,628. "Improvements in or connected with means for transmitting signals made by flashes of light, and recording the transmission and receipt of signals made by flashes of light or other visual signs." J. B. Annibal Lege, J. C. E. Carre, and M. L. Isaacs. Dated December 5th. The object of the invention is to obtain a portable, compact, inexpensive, exact and simple instrument, which may be adapted to record upon a single strip of paper messages transmitted and received. 7 claims.

23,745. "Improvements in electricity meters." G. A. J. Telge. Dated December 6th. Relates to an electricity meter in which the pendulum or it may be the balance spring of a clock movement is caused by means of a pivoted or rocking beam under the influence of a solenoid core to undergo variations in length or position or it may be variations in tension such that the difference between the times indicated by the clocks will give a direct measure of the quantity of electricity that has passed through the solenoid. 4 claims.